ISOLDE NEWSLETTER 2026

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ISOLDE Newsletter 2026

Introduction

Luis M Fraile

Welcome to the 2026 ISOLDE Newsletter!

Although almost a year has passed since I took over from Sean Freeman as Physics Section Leader and Collaboration Spokesperson, this is my first opportunity to address the ISOLDE community through these pages. I would like to begin by thanking Sean for the care he took in ensuring a smooth transition and for leaving everything so exceptionally well organised. This made taking over the role remarkably easy.

During his term Sean was a tireless advocate for the ISOLDE facility and its users. Through his engagement with local teams and CERN management, he helped ensure that the facility achievements had the visibility they deserved. He played a key role in shaping the ISOLDE improvements programme (outlined in this newsletter) and the preparations for LS3, initiatives aimed at strengthening the performance and long-term sustainability of our facility. Thanks in no small part to his efforts, ISOLDE is well positioned for the opportunities and challenges that lie ahead. On behalf of the collaboration, I would like to express our gratitude for his leadership and commitment. He leaves a very high standard to follow.

Changes at CERN

A new CERN management structure has been put in place for the 2026-2030 period under Director-General Mark Thomson. As part of the new CERN directorate, Gautier Hamel de Monchenault becomes Director for Research and Computing (RCS), while Oliver Brüning takes over as Director for Accelerators and Technology (ATS). New department heads have also been appointed, including Giovanna Lehmann as Head of Experimental Physics (EP), with Jamie Boyd as Deputy Head overseeing ISOLDE. Malika Meddahi, Said Atieh and Roberto Losito are the new Heads of the Beams (BE), Engineering (EN) and Accelerator Systems (SY) Departments, respectively.

Within SY, Marco Calviani has succeeded Simone Gilardoni as SY-STI Group Leader, with Ana Paula Bernardes as Deputy Group Leader. As part of a wider reorganisation, SY-STI has been restructured into five sections, including the new Target Systems & Projects (TSP), Radioactive Beam Production (RBP) and Laser Systems & Pulsed Particle Sources (LPS) sections, led by Joachim Vollaire, Charlotte Duchemin and Sebastian Rothe, respectively. Joachim will continue as ISOLDE Technical Coordinator, while ISOLDE contacts for targets and lasers remain unchanged. In the Beams Department, Bettina Mikulec has been appointed BE-OP Group Leader. José Alberto Rodríguez continues to oversee ISOLDE operations as BE-OP-IS setion leader, with Erwin Siesling as Deputy Technical Coordinator for ISOLDE.

End of Run 3

On 8 December 2025, ISOLDE successfully concluded the CERN 2022–2025 operational cycle (Run 3) on a very high note. During this period, ISOLDE provided beams to over 15 experimental stations and travelling setups, serving our large and diverse international user community. More than 1800 eight-hour shifts were delivered to over 130 IS experiments and beam development runs, with approximately 50 experimental beam times taking place every calendar year. The programme covered the broad scientific landscape characteristic of our facility, spanning nuclear structure studies through decay and reactions, investigations of exotic nuclei and particle emission, the interface between atomic and nuclear physics explored through laser spectroscopy, tests of fundamental interactions and physics beyond the Standard Model, nuclear astro-

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physics, fission studies, condensed matter physics, and applications to medical radioisotopes, life sciences, and biophysics. The present 2026 issue of the newsletter highlights a selection of recent scientific and technical outcomes across this wide range of activities.

The backbone of all these achievements is the outstanding work of our technical teams across the many areas of expertise that keep ISOLDE running and evolving, together with a sustained programme of target, ion source, and accelerator developments. Many thanks to all of them for their competence and commitment. At the heart of these successes lies our remarkably active and creative user community, supported by the ISOLDE Collaboration, which currently counts 17 member institutions. Together with Janne Pakarinen, Chairperson of the ISCC, I look forward to continuing our efforts to strengthen and further develop the ISOLDE scientific programme in the years ahead.

The CERN Greybook presently lists close to 1000 ISOLDE users, while 630 active users were registered in the CERN human resources database at the end of 2025. The Greybook also catalogues almost 200 research teams associated with ISOLDE, representing a significant fraction of the total number of teams across CERN. In 2025 alone, users from more than 49 nationalities and over 27 countries came to ISOLDE to perform experiments.

The end of the 2025 campaign also marked the conclusion of the EURO-LABS funding period supporting user access to ISOLDE, which had been running since 1 September 2022. During this time, ISOLDE delivered nearly three times the originally committed beam time and fully used the allocated travel and subsistence budget of 330 kCHF. In addition, extra funds were secured towards the end of 2025 to further support users coming to perform experiments at ISOLDE.

EURO-LABS also funded a fellowship position for beam development, held by Lukas Nies, which has since transitioned into a staff contract. In addition, the programme partially funded the technical user support activities of Oscar Fjeld, whose assistance to users has been highly valuable. His position continues, now fully funded by the ISOLDE Collaboration. A reminder of the obligations associated with EURO-LABS support, including acknowledgement requirements and open-access provisions, is presented in the News for Users section.

The earlier start of the long shutdown for ISOLDE (at the end of the 2025 running period) was envisaged to allow the implementation of major upgrades and developments within the ISOLDE Improvement Programme (IIP), which is now well underway. The IIP brings together a broad range of consolidation, upgrade, and development activities supported through CERN's midterm planning, with the ISOLDE Collaboration committing contributions of 3.75 MCHF for the 2025–2030 period. Even our most regular users will be struck by the scale and variety of the interventions currently taking place across the facility, all aimed at strengthening ISOLDE's performance and reliability and at enhancing scientific capabilities for the years to come. Further details on the ongoing work and planned developments can be found in the excellent contribution by Joachim Vollaire later in this issue. At the same time, efforts are being made to maintain some scientific activity through offline and standalone operation of several experiments until August 2026, using stable ions and long-lived radioactive sources.

The ISOLDE programme

The ISOLDE programme is guided by the ISOLDE and Neutron Time-of-Flight Experiments Committee (INTC), the Programme Advisory Committee responsible for evaluating proposals and recommending them for approval to the CERN Research Board. I would like to thank Marek Pfützner, former Chair of the INTC, for his dedicated work over the past years, and extend a warm welcome to Silvia Leoni, who took over the role after the February 2026 meeting. Hanne Heylen continues her extensive work as Scientific Secretary, providing essential support to both the committee and the ISOLDE user community.

The scientific output of the facility remained impressive in Run 3, with approximately 50 high-impact publications produced per year. We should be especially proud that no fewer than 77 PhD theses connected to ISOLDE research were successfully defended during the 2021–2025 period. In recognition of the essential role that young researchers play in the strength and future of our community, the ISOLDE Collaboration has established the ISOLDE PhD Prize. The 2026 prize will be presented during the ISOLDE Users Meeting to be held from 25 to 27 November 2026 (please mark the dates in your calendars!) and will include an invited talk by the awardee. Supervisors from ISOLDE Collaboration member institutes are warmly encouraged to nominate outstanding theses defended between August 2025 and July 2026 and submit the nomination to the selection committee (G. Georgiev, K. Lynch, W. Nörtershäuser and M. Pfützner).

As ISOLDE collaboration spokesperson I was invited to present the ISOLDE programme to the CERN Scientific Policy Committee on 24 March 2026. The presentation focused on the current status of the ISOLDE programme, recent achievements, and future developments, continuing the important effort to highlight the scientific value and uniqueness of ISOLDE in particular, and of CERN's nuclear physics facilities more broadly.

It is worth noting that October 2025 marked a decade since the first HIE-ISOLDE experiment, which investigated the structure of ^{74,76}Zn via Coulomb excitation using Miniball, with radioisotope beams accelerated solely by Cryomodule 1 (CM1) to 4 MeV/u. The decennial milestone was featured in the *HIE-ISOLDE: 10 years, 10 highlights* news item on the CERN homepage. The performance degradation of HIE-ISOLDE observed after ten years makes the refurbishment of CM1 absolutely necessary (see the contribution by J. Vollaire in this issue).

Scientific results, not only from HIE-ISOLDE but from the broader ISOLDE experimental programme, were presented and discussed at the ISOLDE Workshop and Users Meeting 2025, held at CERN from 3 to 5 December. The scientific programme included 20 invited talks, 33 contributed oral presentations, and 47 posters, for a total of 100 contributions. The attendance, with 167 participants registered in person and 122 more connecting online, reflects the strong engagement of our community.

The 2025 run saw several significant operational achievements. Higher proton energy of 1.7 GeV from the PS Booster to the GPS target led to improved yields for light nuclei (notably for experiments IS690 at SEC and IS764 at VITO), anticipating the promising prospects of 2 GeV proton operation at both separators following the long shutdown. In addition, higher-intensity proton beams at 2.5 μA, made possible through a special radioprotection derogation, enabled studies at the limits of stability near the important ^{100}Sn region. These included IS745 on ^{96}Cd at ISOLTRAP (performed with count rates as low as 0.01 ions per second!), IS775 on ^{98,99}Cd at MIRACLS, and IS772 on ^{99,100}In at CRIS. Selected ISOLDE results from some of these experiments were featured in the CERN EP newsletter, which regularly includes contributions from ISOLDE.

In addition, I would like to draw attention to the forthcoming Focus Point on ISOLDE in *The European Physical Journal Plus*, titled "Exploring the Frontiers of Physics with Radioactive Ion Beams". This topical issue offers a timely opportunity to present a broad overview of recent developments at ISOLDE, alongside future plans and upgrades. It will include original research papers, reviews, and technical notes spanning the full breadth of ISOLDE science and instrumentation, and will be published in an online, hybrid open-access format. The Focus Point will be handled by Guest Editors K. Blaum, L.M. Fraile, J. Pakarinen, and M. Pfützner, with A. Kastberg serving as Managing Editor. Contributions can be submitted via the journal's Editorial Manager system until the deadline at the end of September 2026, following the submission guidelines. I strongly encourage the community to consider contributing, in order to showcase the breadth, quality, and future potential of the ISOLDE science.

Looking ahead: ISOLDE and the future of Non-Collider Physics at CERN

CERN has started the process of shaping a long-term roadmap for its Non-Collider Physics Programme, covering the years 2027–2046. The dedicated task force assigned to this effort (Gianluigi Arduini, Johannes Bernhard, Jamie Boyd, Urs Wiedemann, and Markus Brugger, chair) has the daunting mission to identify the most compelling scientific directions, key milestones, and the infrastructure and resources needed to support them in the short, medium, and long term, and to advise the CERN management on the subject. The initiative recognizes that programmes beyond the high-energy frontier are a vital part of the scientific landscape at CERN, and reflects the ambition to make the best possible use of CERN's formidable accelerator complex, its infrastructure and its expertise.

The roadmap exercise is expected to address both existing and future facilities, as well as possible new infrastructures at different levels of maturity, while considering scientific impact, uniqueness, competition, feasibility, readiness, and synergies. I am convinced that for ISOLDE this marks an important moment, opening new opportunities for ideas and directions in nuclear structure, fundamental interactions, nuclear astrophysics, applied research and related fields.

Structuring the landscape of potential ideas and developments it is not an easy feat. The INTC is now preparing to invite the community to contribute expressions of interest that could help define the scientific priorities of the coming decades. Initiatives should consider the time scale, project size, and funding requirements, while aiming to establish by early 2027 a framework that could be integrated into CERN mid-term plans. It is expected that the process will help define future decision points, maximize complementary physics output within ISOLDE and establish priorities and directions for years ahead. Obviously, such a process will require strong involvement from the ISOLDE community and should also find ways to integrate technical projects and directions. It is also worth noting that the process aims to capture a snapshot of the situation at the beginning of 2027, while remaining dynamic and open to future updates.

Our vibrant ISOLDE community is encouraged to present bold and compelling ideas driven first and foremost by physics goals, rather than by specific facilities or technologies. CERN is seeking a broad and forward-looking vision to help shape the future of non-collider physics over the next twenty years, and we must ensure that the importance of ISOLDE science remains strongly represented in this process. This is both a major opportunity and an important challenge for our community. Stay tuned for the upcoming INTC call.

News for users 2026

Hanne Heylen

Experimental activities during Long Shutdown 3

ISOLDE is in a 2-year shutdown period, during which several major upgrade and civil engineering activities will take place. This limits the experiment-related work that is possible in the ISOLDE hall. To ensure that we can coordinate the many ongoing and upcoming activities effectively, we ask you to share your plans with us as soon as you know them. This includes not only larger projects, but also smaller activities such as measurement campaigns with sources, planned upgrades to your setup, maintenance periods, or times when you expect big shipments in the SAS.

To keep everyone informed, a weekly overview highlighting the most important activities is published at https://isolde.web.cern.ch/isolde-hall-activities-ls3. An overview schedule is also available with the latest known information. Please note that exact dates can often only be confirmed very close to the scheduled time and may shift depending on the progress of the work.

Upcoming INTC meetings

The next INTC meeting in November 2026 is dedicated to receiving input for the long-term roadmap for Non-Collider Physics at CERN. Regular submissions of proposals will resume from February 2027 onwards. The February meeting is expected to be dedicated to HIE-ISOLDE, and the May 2027 meeting to low-energy physics. Further details will be communicated following the November meeting. The scope of later meetings will be defined in due course. Until the end of LS3, existing experiments will remain formally active for reporting purposes to funding agencies and other stakeholders. At the end of LS3, they will be officially closed. Any experiment wishing to run after LS3 will need to submit a new proposal.

User registration and access to the ISOLDE facility

A full description of the procedure for registering at CERN is given on the ISOLDE website. Note that the teamleader and deputy teamleader who submits the information *must* have a valid CERN registration. This also applies to paper forms which have been signed at the visiting institute. Please register under **"ISOLDE"** as your experiment and **"USER"** as status.

All information for getting access to the ISOLDE facility is outlined on this page on the ISOLDE website.

Safety courses

There are a variety of training courses, managed via the CERN training hub, required before access to the ISOLDE hall can be granted. These are divided into classroom courses, which take place at the CERN training centre in Prevessin, and online courses which can be taken via the CERN online training. Enrollment for the classroom courses should take place before coming to CERN (at least 2 weeks before the course takes place, otherwise, they might be cancelled). If a user is not yet registered, an email can be sent to safety training: safety-training@cern.ch. However, once registered it will be still necessary to register for the hands-on courses in the CERN training hub in order to validate the training.

Please note that during the shutdown period, the ISOLDE RP classroom course is only given once per month instead of once per week, so please plan your travel accordingly. Contact the physics coordinator if this timing poses a problem.

After completing the required classroom courses, online refresher courses are now available following the initial three-year validity period.

Safety in the ISOLDE hall

To access ISOLDE, you must wear, at a minimum: a dosimeter, safety helmet, safety shoes, and clothing that completely covers your legs, typically long trousers. Before leaving the facility, always check yourself on the hand-foot monitor.

All equipment must be clearly labelled with contact

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information, setup details, and the period it will be there. If any items need to remain at CERN for longer periods, please contact the physics coordinator to arrange suitable storage. All items must be checked by RP before being removed from ISOLDE or when opening the beamline or experimental chamber. Please note that radioactive items must be added to TREC and stored in the designated cupboard.

In case of doubt, please don't hesitate to contact the local responsible person for your setup, the physics coordinator or the EP safety office (Letizia Di Giulio and James Devine). The list of contacts for safety both for local experiments and visiting setups can be found via https://isolde.cern/safety.

ISOLDE Publications, open access and CERN EP preprints

ISOLDE should be mentioned in the abstract of articles related to experiments performed at the facility and, if possible, the ISOLDE team should be mentioned in the acknowledgements. Experiments which have benefited from previous **ENSAR2** funding at ISOLDE should also mention this in the acknowledgements of any articles which emerge and which should echo the following: *This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654002.*

For **Eurolabs** support, publications should acknowledge in the following way: *"The research leading to these results has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement no. 101057511."*

Please note that under CERN's general conditions, all publications originating from a CERN experiment or featuring a CERN author must be published as open access. Detailed information on open access publishing can be found on this dedicated website, supported by the CERN Scientific Information Service. New agreements have been signed with numerous publishers which facilitate OA publishing with a CERN author. In many cases publication costs will be covered centrally at CERN if there is at least one CERN-affiliated author in the author list. For IOP and the APS publications, costs can be covered even without a CERN author as long as the ISOLDE collaboration and IS number are mentioned e.g. "CERN, ISOLDE Collaboration, ISXXX" in the collaboration field of the submission form, and this should be added to the paper itself.

In case of any further questions, authors can ask the experts in the CERN library questions via email: open-access-questions@cern.ch.

ISOLDE papers can also be uploaded to the CERN EP preprint server, which will allow them to receive a CERN-EP number as is done for many other experiments at CERN. Details on the submission process can be found here. If there are any questions about this process, please contact the physics coordinator.

Publications on CDS

There is a specific area of the CERN Document Server from which all ISOLDE spokespeople and contacts will be able to upload DOI links (and extra information if required). Once you have signed in with your CERN credentials, you should be able to upload any new articles or theses. The link to use is here. If there are any problems with uploading, please contact the physics coordinator.

Open data

Please note that having an open data management programme is a requirement for the receipt of EUROLABS support. ISOLDE has also recently published an open data policy, following approval by the ISCC, and this can be found here.

Safety at ISOLDE: Recent Developments

Hanne Heylen

Over the past years, several measures have been implemented to improve how safety-related aspects of everyday activities are managed at ISOLDE. Below, we summarise these improvements, with links to supporting documents available on EDMS for further information. Please do not hesitate to contact the ISOLDE Physics Coordinator if you cannot access these files.

Technical support

The ISOLDE collaboration has hired Oscar Fjeld as a dedicated mechanical technician to support experiments with mechanical design, construction, and installation work. Since he is hired for five years, he can build up experience to also support recurring operational tasks that carry a certain level of risk, including the handling of cryogens. Under his lead, the mechanical workshop in building 508 has been reopened and the electronics workshop in building 275 is currently being refurbished to reestablish a dedicated space for soldering and small electronics work.

Chemicals

Several legacy chemicals have recently been disposed of, including unlabelled or unknown substances that required testing, which is unfortunately complex and costly (e.g. testing can cost ∼300 CHF per sample). To avoid similar situations in the future, chemicals must be tracked in CERES with clearly assigned ownership and location, and unused chemicals should be transported to waste by the owner once no longer needed. The storage for chemicals in the hall is being upgraded, with new cupboards and appropriate segregation of chemical types. In addition, a common ISOLDE pool of frequently used chemicals has been established to avoid unnecessary duplication (e.g. isopropanol) between collaborations.

Radioactive equipment and sources (EDMS 2917398)

A new, centralised storage area in 170/R-020 has been established, including a fireproof cabinet for contaminated equipment, a new safe for radioactive sources with each source stored in a dedicated colour-coded box, and a dry-air cabinet for detectors and other sensitive equipment. All radioactive equipment must be tracked via the TREC tool, providing a clear overview of item locations and responsible persons. Legacy items previously stored in various locations have been inventoried and sorted with the support of RP. The use of radioactive sources in the ISOLDE pool is explicitly limited to nominated Source Responsible Persons, appointed by the ISOLDE Physics Coordinator (memorandum: EDMS 2953758).

Storage

With the experimental hall becoming increasingly full, finding sufficient storage space is becoming challenging. Therefore, storage space needs to be coordinated: the ISOLDE hall (for frequently used or radioactive items), building 275 (for sensitive equipment), and long-term storage (for items not needed in the near future and accessible with approximately one week's notice). In addition, experimental collaborations are requested to return equipment that is not used for extended periods to their home institutes, and to send obsolete items to waste. All stored items must be clearly labelled with contact information.

Change management and documentation

The change management process (EDMS 3325038) for large changes to experimental setups or new initiatives has been clarified to ensure that modifications are properly reviewed, their impact is understood and documented. All changes must also be consistently reflected in the ISOLDE integration drawing, which serves as a key reference for planning and coordinating future activities.

Safety files and procedures for individual instruments (CERN-0000159971) have been substantially improved over the past years and now provide a comprehensive reference for safety-relevant information. Each collaboration is responsible for keeping these documents up to date.

Miscellaneous

- New LN_2 dewars have been bought for shared use. Discussions on installing a larger LN_2 tank after LS3 are ongoing.
- Use of the overhead crane by users is permitted following EDMS 3101935. However, the recommended option remains to make a handling request via EDH.
- A pool of safety shoes for short-term visitors is available in building 508.
- EP safety has managed the installation of a gas distribution line for flammable gases, needed for several experiments performed on the HIE-ISOLDE beam lines
- Old lead shielding bricks with peeling paint have been replaced with coated lead bricks (available in 170/R-020).
- The chemical laboratory in building 508 has been equipped with a new glovebox and fume hood.

ISOLDE facility

An update on the LS3 start at ISOLDE

Joachim Vollaire for the technical coordination

ISOLDE Improvement Programme

In the 2025 ISOLDE Newsletter, the main objectives and preliminary scope of the ISOLDE Improvement Programme (IIP) for Long Shutdown 3 (LS3) were presented. At the time, several activities were still included in the COFUND request, supported by a significant contribution from the ISOLDE Collaboration, submitted for approval through the CERN Mid-Term Planning 2025 (MTP 2025) exercise. Following the MTP 2025 arbitration, the full scope of the programme has now been consolidated with the approval of several additional activities and projects alongside those already approved during previous years, such as the ISOLDE primary areas ventilation upgrade, the RILIS laboratory consolidation and the ISOLDE Beam Dumps Replacement and Sustainability (IBDRS) project. As a positive outcome of the MTP2025, several systems across the entire radioactive ion beam production, delivery, and post-acceleration chain will undergo consolidation and upgrade during LS3.

On the proton delivery side, the upgrade of the BTY transfer line was approved in 2025 to address both ageing infrastructure and performance limitations between the PS Booster and ISOLDE. As the BTY line was not upgraded during LS2 as part of the LIU (LHC Injectors Upgrade) project, ISOLDE currently does not benefit from the 2.0 GeV beam energy that the PS Booster is now capable of delivering, with operation remaining limited to 1.7 GeV for GPS and 1.4 GeV for HRS. The LS3 upgrade includes the reconfiguration of the vertical dogleg on the PS Booster side of the beamline, the consolidation or replacement of several magnets, including the end-line focusing quadrupoles that exhibited significant signs of corrosion, as well as the installation of new steering magnets capable of directing the beam onto the targets at higher energy, together with the replacement of all power converters. The upgrade will enable 2.0 GeV operation while maintaining the possibility to operate at 1.4 GeV for isotopes with higher production cross-sections at lower energy. In addition, the operational flexibility of the facility will be greatly enhanced through pulse-to-pulse modulation and the possibility to alternatively deliver proton pulses to GPS, HRS, or the MEDICIS target. Finally, the replacement of the existing solid steel yoke magnets with laminated designs for the final focusing quadrupoles will also contribute to optimizing energy consumption.

Several activities targeting the mass separators and low-energy beamlines were also approved, including the upgrade of the NMR probes for the HRS separator magnetic field regulation, enhancements to the ISCOOL cooler/buncher primary and secondary hardware and diagnostics, the required hardware modifications to allow pulsing of the central beamline (CA0), as well as the consolidation and improvement of beam instrumentation across the ISOLDE facility.

For the REX/HIE-ISOLDE post-accelerator, several consolidation and upgrade activities aimed at reducing commissioning time, maximizing the time available for physics and recovering the performance in terms of maximum beam energy will be implemented. These include studies for the identification and mitigation of discharge sources in REXTRAP, the installation of a new electron collector for the REXEBIS and the deployment of new 101 MHz RF amplifiers and low-level RF (LLRF) systems for the normal-conducting cavities.

For the superconducting HIE-ISOLDE linac, a grad-

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ual degradation in performance has significantly impacted the high-energy physics programme in recent years. To address this, a series of measures will be implemented during LS3, including the refurbishment of Cryomodule 1 (CM1), the installation of additional NEG pumping upstream of CM1, the integration and commissioning of a new 2 kL liquid-helium dewar in the cryoplant, as well as studies for an LN_2/GHe heat-exchanger cooling system for the cryomodule thermal shields. Together, these activities aim to restore and sustain the performance of the full REX/HIE-ISOLDE accelerator throughout Run 4.

In parallel, the procurement of the missing components required for the assembly of the spare Cryomodule 5 (CM5) was also approved as part of the long-term strategy for the cryomodule maintenance horizon 2030 and beyond. The availability of a spare cryomodule will significantly reduce the risks associated with major failures of the superconducting linac and improve the long-term maintainability.

Start of LS3 for ISOLDE

The year 2025 was particularly demanding, as the technical teams had to simultaneously support physics operation, prepare the LS3 activities, and address several technical issues inherent to the end of a running period. Despite these challenges, significant effort was invested in preparing the shutdown activities and ensuring that major projects could start as soon as beam operation ended. At the time of writing, the LS3 shutdown at ISOLDE started approximately six months ago, well ahead of the shutdown of the rest of the CERN accelerator complex. This anticipation proved extremely beneficial as activities have started at a very fast pace, capitalizing on the availability of technical support teams while facilities operation was still ongoing elsewhere at CERN. By preparing several activities in advance and rapidly transitioning into execution mode, the impact of LS3 is already clearly visible across the facility, with major interventions now ongoing in parallel in many areas.

One of the first major LS3 activities that is even already completed is the ISOLDE Primary Areas Ventilation and Fire Safety upgrade project, which had already significantly progressed during the 2025 physics campaign in order to minimize co-activity with the IBDRS project during LS3 (see Fig. 1 for the different phases of the new infrastructure construction). As presented in last year's newsletter, the project was initiated following a fire safety review assessing the potential radiological impact of a fire in the ISOLDE target area. The upgrade included the extension of Building 197 to accommodate the new HVAC equipment serving the primary areas, together with the implementation of charcoal filtration for radioactive volatile species, fire dampers, and the physical separation of the ventilation infrastructure from the experimental hall.

Figure 1: Left: Different phases of the construction of the Building 197 extension, with the top picture showing the internal metallic structure during assembly and the bottom picture the completed building. Right: The 10 m-high ventilation stack installed on top of the new building.

The project represented a particularly challenging coordination effort, as a large fraction of the civil engineering, installation, and integration activities had to be carried out in parallel with the 2025 physics campaign. This required careful cohabitation between construction activities and operation, with frequent impacts on access conditions in and around the ISOLDE hall. The project team would therefore like to thank the ISOLDE physics community for their patience and understanding. As can be seen in Fig. 1, the building, including its 10 m-high ventilation stack, was completed before the end of the run. A closer look at the picture on the right reveals that a special guest visited ISOLDE just in time for the end-of-year winter party.

Following the proton stop, the final phase of the project focused on connecting the new ventilation infrastructure to the existing ductwork embedded within a concrete shielding structure designed to reduce stray radiation levels caused by back-scattered particles from the GPS target station (see top right picture in Fig. 2).

Figure 2: Top left: Concrete shielding structure enclosing the original ventilation ductwork. Top right and bottom left: Demolition of the shielding structure to expose the embedded ducts and pipes. Bottom right: Final configuration after installation and connection of the new steel ducting to the existing infrastructure.

The structure had to be carefully demolished and the ducts exposed without damaging them or allowing debris to fall into and block the lower sections (see top right and bottom left pictures in Fig. 2). After recovery of the ducts, welding experts from CERN's EN-MME group welded transition pieces onto the existing ductwork, allowing EN-CV to connect the old ventilation infrastructure to the new installation. These activities have now been successfully completed during the first months of LS3, allowing the commissioning of the new installation and marking the conclusion of a major safety upgrade for the ISOLDE facility. The new infrastructure ensures compliance with modern radiation safety and confinement standards for decades to come.

One of the most visible manifestations of the start of LS3 at ISOLDE is undoubtedly the IBDRS (ISOLDE Beam Dumps Replacement and Sustainability) worksite, which has dramatically transformed the area around the facility with the occupation of parking areas and the impressive worksite installation. The IBDRS project entered its execution phase immediately after the proton stop. The first activities focused on core sampling campaigns aimed at validating the FLUKA calculations used to estimate the activation profile of the soil and to determine the volume of radioactive material requiring separate handling from conventional excavation material.

Figure 3: Different phases of the soil removal activities for the IBDRS project. Top: Protective tarpaulin installed over the target area during the final winter months, ahead of excavation work. Middle: IBDRS worksite during the excavation and core-sampling campaign. Bottom left: RP team performing radiological checks on a truck leaving the site. Bottom right: Soil sampling activities for gamma-spectrometry analysis.

Afterwards, the removal of the non-radioactive soil covering the target area was carried out over several weeks. At the peak of the operation, up to 40 trucks per day left the ISOLDE site after thorough radiological checks performed by the RP teams, and the material was transported to a temporary storage area in the SPS zone. Once the conventional soil excavation had been completed, the project entered a second phase involving the handling of the activated soil (see Fig. 3). This material is currently being stored in dedicated areas on the work site and will later be reused to fill the excavation above the future underground technical building that will house the new beam dumps and their shielding infrastructure.

Figure 4: Progress of the IBDRS excavation and dismantling activities. Top: Target area after completion of the soil removal campaign, exposing the civil-engineering infrastructure and surrounding buildings. Bottom: Ongoing dismantling of the beam-dump shielding, showing the infrastructure used for cleaning and handling shielding blocks, together with the crane installed for removal operations.

Following the completion of the excavation activities, the project has entered the phase involving the dismantling of the shielding blocks and removal of the existing GPS and HRS beam dumps. These activities are currently ongoing and are expected to be completed during June. Once the dumps have been fully removed, construction of the new underground technical building that will house the replacement beam dumps and associated shielding infrastructure will begin.

Inside the machine, several preparatory activities have already taken place for the BTY line upgrade. On the PS Booster side, the BTY magnets were removed during the injectors technical stop in January to allow the TE-MSC teams to refurbish them ahead of the peak LS3 workload (see Fig. 5 left picture). On the ISOLDE side, progress remained more limited during the first months of LS3 due to access restrictions linked to the ventilation upgrade project and shielding block handling activities associated with the IBDRS project above the target area. Nevertheless, several enabling works were successfully completed. In particular, the trenches formerly used by the ISOLDE robots were filled with concrete to support the weight of the BTY dipole magnets during handling for the beamline upgrade (see Fig. 5).

Figure 5: Preparatory activities for the BTY line upgrade during LS3. Left: BTY transfer line on the PS Booster side after the removal of the magnets for refurbishment and consolidation activities. Right: Former ISOLDE robot trenches filled with concrete in preparation for the future installation and handling of the upgraded BTY beamline magnets.

Activities in the Experimental Hall

A visitor walking through the ISOLDE experimental hall would also immediately notice the major transformations that have taken place since the end of 2025. The RILIS laboratory and the ISCOOL high-voltage cage have been completely dismantled to allow the construction of the new RILIS laboratory infrastructure, which will provide additional floor space and improved safety and operational conditions (see Fig. 6).

At the entrance of the hall from Building 508, a new metallic platform has also been installed to accommodate the new power converters for the electrostatic elements of the low-energy beamlines, marking another visible step in the modernization of the ISOLDE infrastructure.

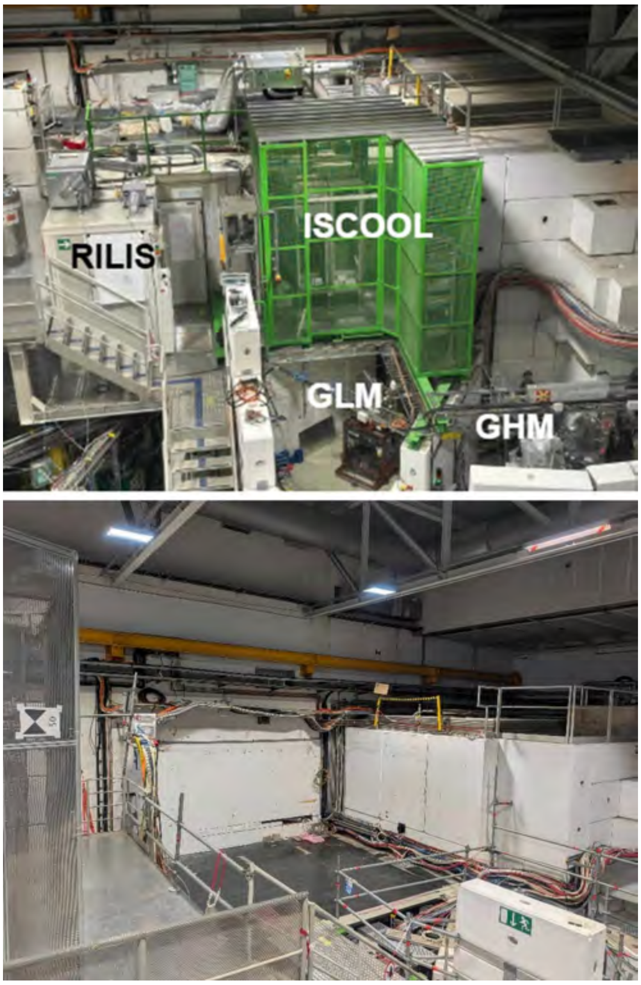


Figure 6: Dismantling activities for the RILIS laboratory consolidation project. Top: RILIS laboratory area before the start of the LS3 works. Bottom: Empty space left after the dismantling of the RILIS laboratory and the ISCOOL high-voltage cage in preparation for the construction of the new infrastructure.

Another major activity during the first months of LS3 was the removal of Cryomodule 1 (CM1) from the HIE-ISOLDE linac bunker for refurbishment at the SM18 facility (featured in the cover of the newsletter). The operation required extensive preparation and coordination across several CERN groups for handling, radiological checks, transport, and logistics. Given the unique nature of the superconducting cryomodule, the transfer involved temporary road closures around ISOLDE and coordination with the host state authorities for the border crossing. The refurbishment of CM1 is a key step towards restoring the performance of the HIE-ISOLDE linac.

Figure 7: New platform in Building 170 for the installation of low-energy beamline electrostatic power-supply racks.

Figure 8: Top: Transport of the first HIE-ISOLDE cryomodule (CM1) from ISOLDE to the SM18 facility. Bottom: Arrival and handling of CM1 in SM18, where it will be refurbished and prepared in the clean room for future operation at ISOLDE.

Conclusions

Although significant progress has already been achieved during the first months of LS3 for ISOLDE, a little less than two years of work still lie ahead before the completion of all planned activities and the recommissioning of the facility in preparation for the restart of physics in 2028. Many challenges remain, including known technical constraints as well as undoubtedly new issues that will emerge along the way in a programme of this scale and complexity.

Nevertheless, thanks to the extensive preparation work carried out over the last years, together with the strong support, expertise, and commitment of the CERN technical teams and the ISOLDE community at large, there is strong confidence that LS3 will be successfully completed and will place ISOLDE on an excellent trajectory for Run 4 and beyond. In parallel, the preparation of the next package of upgrades and improvements for ISOLDE has already started, with the objective of ensuring that the facility continues to evolve and maintain its leading role in the coming decades.

News from target and ion source development team (TISD)

Matthias A. Grasser, Simon Stegemann, Serdar Usta,
Valentina Berlin, Kevin Zinke, Timo Knobloch for the
SY-STI-RBS, SY-STI-LP sections

1. Targets in Run 3

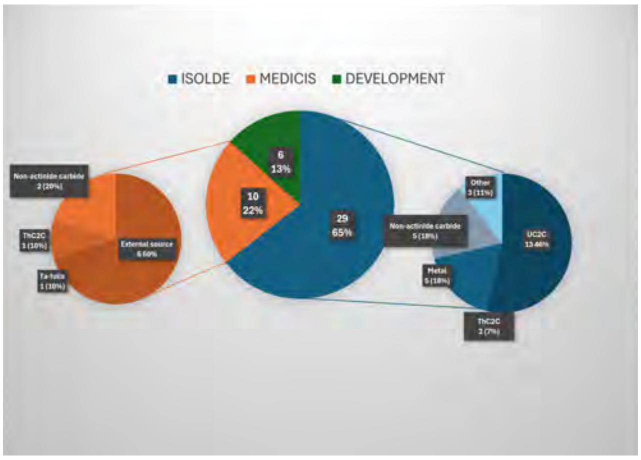


Figure 1: Target production 2025.

2025 was the final operational year of Run 3 for ISOLDE before Long Shutdown 3 (LS3). Although the injector complex will operate until mid-2026, it was decided—after careful deliberation—to align the ISOLDE beam-dump replacement project with the post-LS3 restart. Consequently, 2025 was an exceptionally dense year for both target production and scheduling. Figure 1 shows the distribution of the targets produced. Nearly 30 targets were manufactured, with actinide materials (UC_x, ThC_x) accounting for more than 50%, consistent with previous years. Comparing annual production (see Table 1) across Run 3 reveals a clear upward trend, particularly in the final two years.

2021	2022	2023	2024	2025
15	24	19	31	28

Table 1: Annual target production during Run 3.

Figures 2 and 3 show the produced target materials and ion sources throughout Run 3. The material distribution follows the pattern reported in [1], which summarizes 16 years of production since 2000. Carbide materials dominate, accounting for over 70% of all targets. Among these, UC_x is by far the most widely used, representing roughly 60% of the total. Lanthanum carbide was the second most used material, especially in 2025, when an improved heat-screen assembly was implemented to enhance temperature homogeneity (see Section 19. LaC_x mechanical target development).

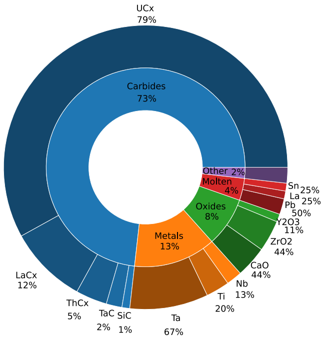


Figure 2: Target material production throughout Run 3.

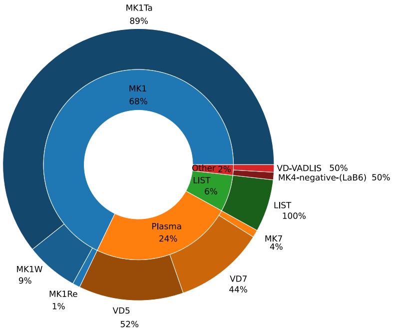
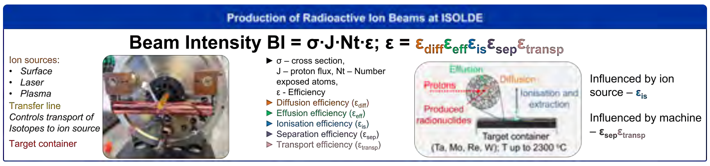


Figure 3: Ion source production throughout Run 3.

Among the ion sources, the hot cavity (MK1) source was predominantly used. Note that the resonance ionisation laser ion source (RILIS), which is used about 60% of the on-line beam time, preferably utilizes a tantalum hot cavity (MK1Ta), as it features better extraction characteristics. Plasma ion sources for species with high ionisation potential were second most used.

2. A space for developing and producing non-radioactive nano target materials - Extension of the chemical lab

The SY-STI-RBP section (formerly RBS) is responsible for the target manufacturing to produce radioactive ion beams for the ISOLDE and MEDICIS physics programmes. This entails the continuous development of target materials and ion sources to increase yields, reliability and access to new isotope beams. In recent years, development of nanomaterials has regained interest, due their potential for increased diffusion $\varepsilon_{\mathrm{diff}}$ efficiencies. In 2025, commissioning of the Actinide Nanolab was completed and the first batch of nano-UC_x was successfully produced and tested at ISOLDE (see Section 18). As the name suggests, the Actinide NanoLab is reserved to actinides. While UC_x is used predominantly at ISOLDE, development of nanostructured non-actinide materials is however of interest (see Section 15), for which the appropriate technical infrastructure is currently missing.



Production of Radioactive Ion Beams at ISOLDE

Beam Intensity $BI = \sigma \cdot J \cdot Nt \cdot \varepsilon$; $\varepsilon = \varepsilon_{diff}\varepsilon_{eff}\varepsilon_{is}\varepsilon_{sep}\varepsilon_{transp}$

Ion sources:
- *Surface*
- *Laser*
- *Plasma*

Transfer line
Controls transport of Isotopes to ion source
Target container

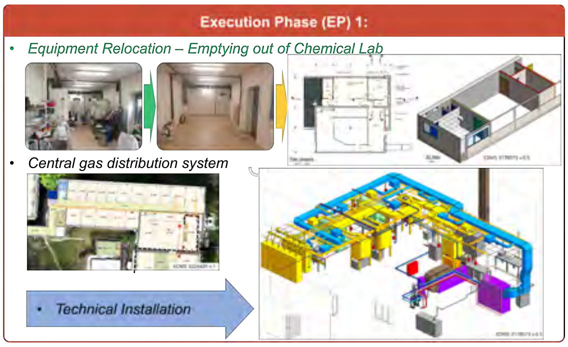
- ▶ σ – cross section, J – proton flux, Nt – Number exposed atoms, ε - Efficiency
- ▶ Diffusion efficiency (ε_{diff})
- ▶ Effusion efficiency (ε_{eff})
- ▶ Ionisation efficiency (ε_{is})
- ▶ Separation efficiency (ε_{sep})
- ▶ Transport efficiency (ε_{transp})

Influenced by ion source – ε_{is}

Influenced by machine – $\varepsilon_{sep}\varepsilon_{transp}$

Figure 4: Schematic view of the radioactive ion beam production at ISOLDE and beam intensity influencing factors [2].

Therefore, to foster development of non-radioactive nanomaterials, refurbishment of the respective laboratory infrastructure was launched. The updated laboratory, shall separate chemical activities from office space, development from production activities, and group and optimize processes and their flows, while including risk reduction measures such as dedicated process ventilation, fire compartmentalization, SAS, *etc.*. With this chemical lab extension project, formerly spread-out laboratories and storage spaces in building 26 and 3 (first and ground floor), will be replaced with one laboratory complex for safe and more ergonomic development and production of future (nano) target materials, following the precautionary principle [3]. The new Nanolab will be situated in B26 and will encompass a chemical laboratory, two nanomaterials laboratories for development and production, which are denoted Nano1, Nano2 and Nano3, respectively, as well as an integrated storage room. This design is derived from the EPFL directive on working with engineered nanomaterials [4, 5, 6]. To ensure this, the laboratory will feature customized, glove boxes, fume hoods, centralized media distribution system and further state of the art laboratory equipment such as a ball mill, automatic pill press and characterization devices.



Execution Phase (EP) 1:

- *Equipment Relocation – Emptying out of Chemical Lab*
- *Central gas distribution system*
- *Technical Installation*

Figure 5: Schematic view of the execution phase (EP) 1 of the chemical lab extension in B26 into a Nanolaboratory [2].

After successfully completing the target material production of Run 3, the chemical laboratory was emptied towards the end of 2025. At the beginning of this year, civil engineering work started in B26, marking the transition from design phase to execution phase (Fig. 5). Project completion is projected towards the end of this year, such that target material development can get to full speed in LS3.

3. Completing the life cycle of pyrophoric targets

Pyrophoric metal carbides such as uranium carbide (UC_x), thorium carbide (ThC_x), and lanthanum carbide (LaC_x) are among the most widely used target materials at ISOLDE (see Fig. 2). Their high cross-sections, high-temperature stability, and porous structure make them exceptionally well-suited for radioactive ion beam production. However, after prolonged irradiation at elevated temperature, radioisotope yields decrease, likely due to irradiation- and temperature-induced microstructural changes. As a result, the materials eventually become pyrophoric radioactive waste. Due to the pyrophoricity, to date, such waste is merely stored at CERN, as no safe disposal pathway exists. To resolve this, chemical stabilization is therefore needed. Because these materials can react strongly with oxidants in ambient air, uncontrolled exposure may lead to self-ignition or thermal runaway, while proton irradiation adds an additional radiological hazard. This project aims to develop a routine chemical stabilization process for ISOLDE Hot Cell 2 that is fully compatible with radiological protection constraints.

Figure 6: Target unit dismantling in hot cell.

The first phase of the work focused on lanthanum carbide, which provided an ideal non-radioactive model for studying pyrophoric behavior. Experiments showed that water vapor, rather than molecular oxygen, is responsible for triggering pyrophoric activation at room temperature. This led to a comparison of the thermal behavior and reaction products obtained under oxygen- and water-vapor-based atmospheres. Based on these findings, humidified argon was selected as the preferred stabilization atmosphere. Introducing hydrogen via water allows part of the metal–carbon bond energy to be released as hydrocarbons rather than entirely as heat, thereby moderating the process exothermicity. For safe operation, the concentration of evolved hydrocarbons must remain below the lower explosive limit; hence, the inlet water vapor concentration is maintained below 2.2%. The low-temperature nature of this route also helps to limit thermal stress and reduce the formation of volatile species.

To test this concept for UC_x, an experimental setup was developed in a reduced-pressure glove box and equipped with *operando* gas sensors for real-time gas monitoring. The reaction regime observed for uranium carbide was similar to that previously identified for lanthanum carbide hydrolysis and ageing under ambient conditions, indicating the formation of a stable end product. For LaC_x, PXRD showed the stabilized product to consist of lanthanum hydroxide and free carbon. For UC_x, the current results indicate a similarly biphasic product consisting of free carbon and an oxygen-containing uranium compound with SEM-EDS, although detailed characterization is still ongoing.

The next challenge is to translate these small-scale findings into a process compatible with hot-cell operation. The project is carried out in close coordination with the HSE/RP group, with PSI supporting the perspective on final disposal. Ultimately, the aim is to complete the final stage of the ISOLDE target life cycle in a safe and technically robust way. Beyond its direct operational relevance, the work also provides new insight into how irradiated actinide carbides evolve under ISOLDE conditions, with potential benefits for both future conditioning strategies and long-term target performance.

4. Nanostructured UC_x at ISOLDE

With the commissioning of the Actinide NanoLab in Building 179, the development of nanostructured uranium carbide (UC_x) at ISOLDE has resumed, paving the way towards its utilization in the post-LS3 programme. The production process follows the concept originally demonstrated in the ActILab prototype [7, 8, 9], but has been substantially re-engineered with respect to safety and reproducibility.

The synthesis route, detailed below, begins with the preparation of nanometric UO_2 by wet milling micrometric UO_2 in isopropanol, yielding an average particle size of 150 nm after 20 cycles at 650 rpm with controlled cooling intervals. This step is critical because particle size directly influences release efficiency, as described by the diffusion model in Eq. (1), and therefore plays a decisive role in determining the overall release performance of the final UC_x matrix [10].

$$\varepsilon_{\mathrm{rel}} = \frac{3}{\pi}\sqrt{\frac{\mu_s}{\lambda}}, \quad \text{with} \quad \mu_s = \frac{\pi^2 D}{r^2}, \quad 2\mu_s\lambda \tag{1}$$

Where D is the diffusion coefficient within the target material, r is the grain radius, λ is the decay constant of the isotope and μ_s is the diffusion time. Note that Eq. (1) assumes a diffusion-dominated release mechanism, *i.e.*, no delay due to effusion, and spherical particles.

In parallel, multi-walled carbon nanotubes (MWCNTs) are dispersed in isopropanol using combined mechanical stirring and probe sonication. The nanometric UO_2 suspension is then transferred into the MWCNT dispersion under continuous agitation. Controlled vacuum distillation removes the solvent while maintaining homogeneous mixing, resulting in a dry nano-UO_2/MWCNT composite powder.

The powder is pressed into pellets using a hydraulic pill press. Approximately 130 pellets are required to fill one standard ISOLDE target container. The pellets are subsequently stacked and inserted into a graphite sleeve.

Carburization is performed on a dedicated pump stand under high vacuum at temperatures up to 2000 ℃. During this step, UO_2 reacts with carbon to form UC_x, while CO/CO_2 gasses and volatile contaminants are removed. After carburization, the target charge is carefully transferred into the inert glove box enclosure with the help of a newly engineered transfer system and loaded into the final production unit for online use.

In total, the complete production of one nano-UC_x target batch requires approximately three weeks, with wet mixing representing the primary bottleneck. While the present workflow is optimized for safety and reproducibility, further efforts toward up-scaling and process streamlining will be essential for routine deployment.

The first nano-UC_x target produced with this protocol was subsequently tested online at ISOLDE. Online tests indicate consistently improved efficiencies for the alkali elements investigated (Na, K, Rb and Cs) compared to the corresponding isotopes produced with conventional UC_x targets (see Fig. 7). As expected, the enhancement is particularly noticeable for short-lived isotopes, where diffusion through the target material grains represents the time-controlling step of isotope release. For Na isotopes, a clear acceleration of the release curve was observed. More generally, the nano-UC_x target shows a reduction of the slow-release component ($\tau_s \downarrow$, $\alpha \uparrow$), indicating modified release dynamics compared to the micrometric material. Importantly, these improvements were obtained despite operating with approximately one third of the conventional target mass, underlining the impact of microstructure on isotope release efficiency.

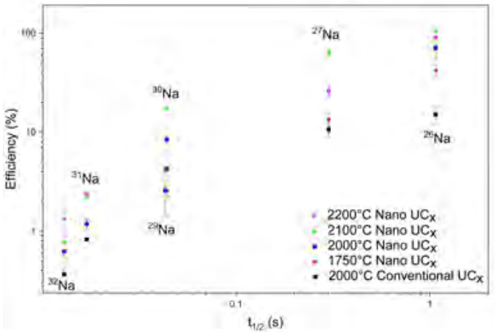


Figure 7: Na extraction efficiency as a function of the half-life for nano-UC_x compared to conventional UC_x.

5. LaC$_x$ mechanical target development

A newly developed target concept was implemented to ensure a more homogeneous heat distribution throughout both the container and the source. In contrast to standard designs, the heat shielding is mechanically separated from the container using spacers and mounting grids. The setup also incorporates round and square shielding elements (Fig. 8) that thermally isolate the temperature differences between the hot tantalum container, adjacent line components, and the cold casserole.

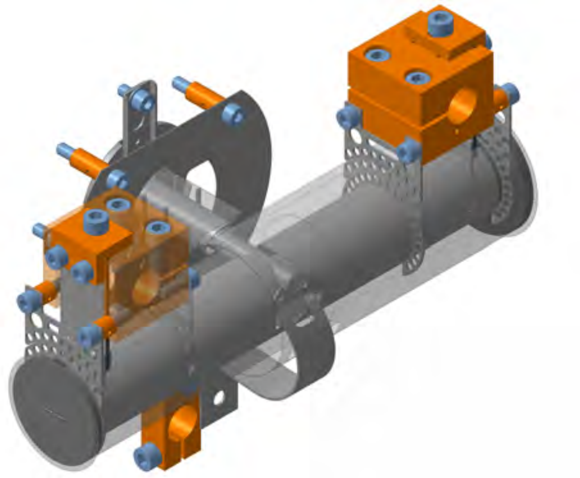


Figure 8: Schematic view of container assembly including the heat shielding.

Extensive prototyping and development preceded the final implementation. The shielding geometry was initially redrawn from paper templates and subsequently converted into CATIA models. These models were then used to generate data files for precision laser cutting of 0.1 mm thick tantalum sheets. To further improve insulation between the two shielding layers, a plug assembly made of carbon-based soft felt was installed on the sides and enclosed with tantalum foils. Openings in the heat shielding, together with a windowed casserole, enabled pyrometer measurements of both the container and the outer perimeter of the shielding. Additional thermocouples were installed for complementary monitoring. At operating temperatures between 1700 ℃ and 1800 ℃, the pyrometer measurements showed a maximum deviation of approximately 120 ℃ between the maximum and minimum (Fig. 9), confirming a highly uniform heat distribution [11, 12]. Meanwhile, temperatures at the outer perimeter of the shielding were around 1100 ℃, indicating effective thermal insulation and a strong temperature gradient.

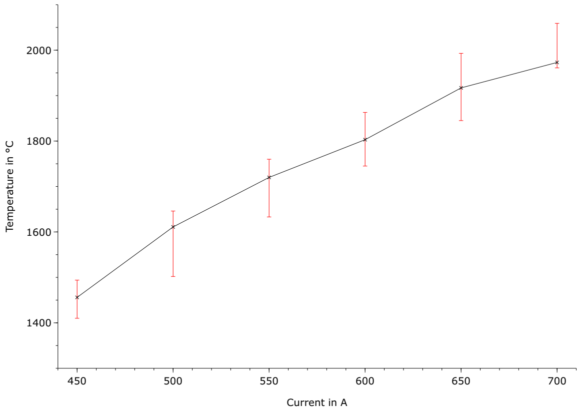


Figure 9: Calibration graph of Target #909.

The homogeneous heat distribution across the entire container volume—verified by both thermocouple and pyrometer measurements—represents a key achievement of this development. In particular, users at ISOLDE reported very positive feedback for the three targets operated in 2025 [11, 12]. These encouraging results suggest that additional targets of this type may be required in the future, and that some shielding components may serve as a basis for standardization in future target production.

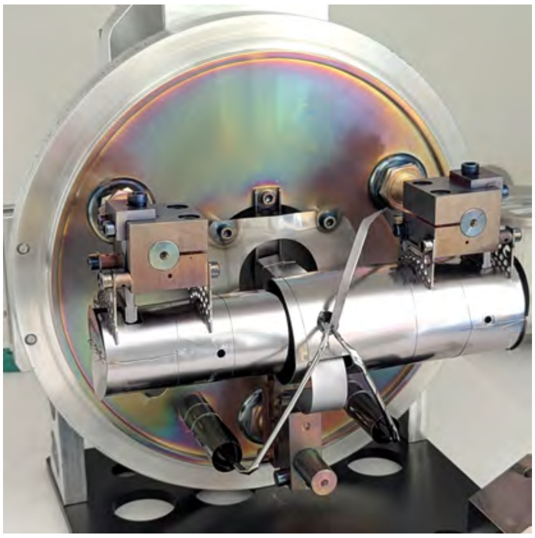


Figure 10: Target #908 after completed offline calibration.

6. Frontend development

While targets are replaced for almost every experiment (40-50 annually), motivated mostly by material aging, the GPS and HRS Frontends are used close to 10 years with annual maintenance during the YETS. During LS3, ISOLDE and BTY proton beamline upgrades will be implemented, which will enable higher proton beam energies and intensities in the future. The BTY proton beamline upgrade will allow ISOLDE to use 2.0-GeV protons as of Run 4, and the ISOLDE beam dump replacement & sustainability project (IBDRS) will conceptually allow utilization of proton currents up to 6 µA in the future. Particularly the latter will strongly impact the radiation field of primary and secondary particles generated during target bombardment, which determine the Frontends' lifetime. As a result, a new Frontend design is necessary to accommodate these upgrades.

Taking this into consideration, the IBDRS project comprises the construction of a new service building above the target area, providing a new interface and better access to the Frontends. Figure 11 shows a preliminary concept of the next generation ISOLDE Frontend.

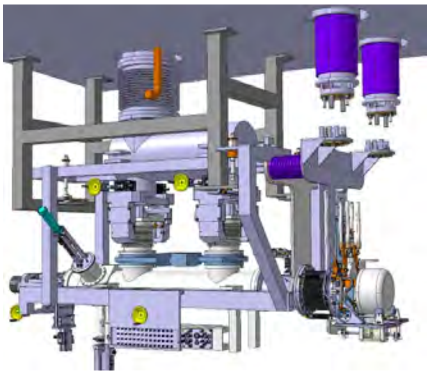


Figure 11: Preliminary new Frontend design.

With both increased proton beam energy and intensity, the Frontend can no longer be serviced inside the target area. As a result, the next generation must allow moving it into and out of the zone remotely. In addition, all service connections—including water cooling, compressed air, high voltage, and the vacuum system—must be operable and re-connectable by remote means. Each sub-assembly is therefore tested independently to verify its functionality. Once validated, all sub-assemblies are assembled into a full-scale mock up for integrated testing to confirm complete system functionality.

Figure 12: Clamping system.

One of the sub-assemblies is the clamping system (see Fig. 12), which enables the connection of the vacuum system to the Frontend. It employs a knee lever mechanism combined with two gears to increase torque and applied force. An aluminium seal placed between the components ensures vacuum tightness.

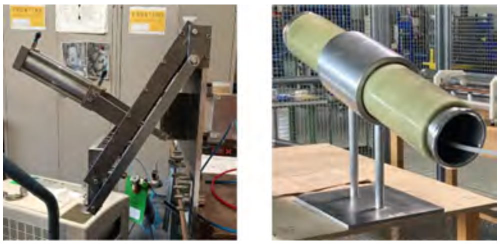


Figure 13: SHV Connector / Boris Tube.

Another sub-system is the shielded high voltage (SHV) connector interface (Fig. 13). This system automatically aligns 32 SHV connectors and engages them remotely using a piston driven mechanism, allowing reliable electrical connection without manual intervention. The Boris Tube is currently under development. It will form the mechanical interface between the IBDRS building and the target area, providing a controlled passage between radioactive and non radioactive zones. The next step will be to assemble a complete mock up to test all subassemblies together and verify the overall mechanical functionality of the entire system such that the new design can be validated for installation after LS4.

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Ground-state properties

Recent measurements and developments at CRIS

Summary of the 2025 running campaign

Jessica Warbinek for the CRIS collaboration

The CRIS experiment at ISOLDE is dedicated to the study of atomic, molecular and nuclear properties at the extremes of the nuclear landscape. By combining the high resolution of collinear laser spectroscopy with the sensitivity of resonance ionization, CRIS can extract ground-state properties even for nuclei produced at rates of few tens of ions per second. Over the last decade, CRIS studied isotopes ranging from light systems in Al to heavy species such as Fr and Ra, including the radioactive molecules RaF and AcF.

During the 2025 campaign, CRIS performed atomic and nuclear structure studies across the nuclear chart, combining laser spectroscopy with decay detection. The first experiment focused on n-rich Ar isotopes, in particular $^{45-48}$Ar. Measurements of electromagnetic moments probed the erosion of the N = 28 shell gap when moving from doubly magic Ca toward Si, where this shell closure disappears. Mean-square charge radii across N = 28 provided additional insight into regional systematics and allowed a comparison with trends reported in literature. During this experiment, also a new field-ionization unit was commissioned. This device ionizes high-lying Rydberg states via electrostatic fields, removing the need for a high-power non-resonant ionization laser. In addition to atomic physics studies, the unit proved effective for exotic species and large contamination, noticeably improving the signal-to-background ratio and the experimental sensitivity.

A run on n-deficient In isotopes complemented the nuclear physics program in 2025. Following recent studies down to ^{101}In [3], further laser and decay spectroscopy was performed. In particular, laser spectroscopy of ^{100}In, with one neutron and one-proton hole relative to ^{100}Sn, was pursued to probe proton-neutron correlations and the onset of collectivity and deformation when approaching N = 50. In addition, the new CRIS decay spectroscopy station (DSS) was applied and commissioned on-line for the first time. The DSS assembly shown in Fig. 1 consists of three Ge-detectors, a plastic scintillator with Si-photomultipliers, and a fast tape station. This setup enables both, decay-assisted laser spectroscopy, through the suppression of stable or long-lived contaminants, and laser-assisted decay spectroscopy via nuclear-state-specific ionization. Isomerically purified beams of ^{106g,m}In were implanted into the DSS and their decays measured, demonstrating a purification of >99%. In the future, this setup will enable decay spectroscopy on pure nuclear states, particularly for lighter species with collapsed hyperfine structure requiring the high resolution of CRIS.

Finally, CRIS performed atomic structure studies of Po$^-$ by measuring the electron affinity of this radioactive element for the first time. This result provides new insight into the chemical properties of Po and highlights the versatility of CRIS for future studies of negative ions otherwise inaccessible to off-line investigations.

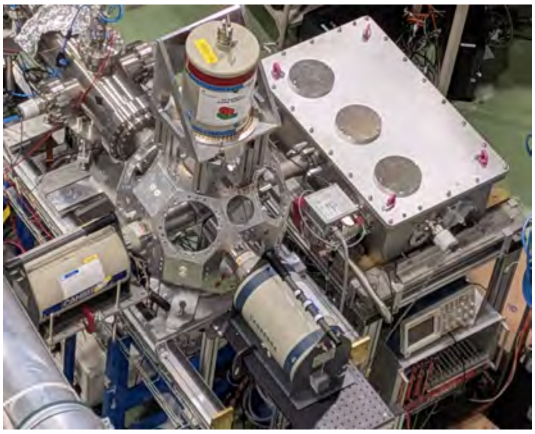

Figure 1: Picture of the new CRIS DSS setup.

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ISOLDE Newsletter 2026

Measuring the electron affinity of polonium

Results of experiment IS728

Carlos Mario Fajardo-Zambrano, Miranda Nichols, Janis Snikeris, Dag Hanstorp, Jessica Warbinek, for the CRIS collaboration

Polonium (Po), element 84 is the first even-Z element without stable isotopes, with most of them being short-lived. ^{210}Po ($t_{1/2}$ = 138.4 d), as an example, is a product of the ^{238}U-decay chain. Understanding the chemical properties of Po is important for medical and environmental purposes, such as developing efficient decorporation treatment methods [1], long term management of depleted uranium mines [2], and designing safe next-generation nuclear reactors [3].

The electron affinity (EA) and the ionization potential (IP) are important characteristics for predicting chemical properties of an element. The first IP of Po has previously been measured at TRIUMF-ISAC and ISOLDE [4, 5], but until now its EA was experimentally unknown. The EA is the amount of energy released when an additional electron binds to a neutral system and its value is extremely sensitive to electron correlation effects, which makes it important for understanding limitations of the independent particle model [6].

In this context, laser photodetachment threshold (LPT) spectroscopy is a standard technique for precision determinations of EAs and has been successfully applied to radioactive astatine at ISOLDE [7]. However, the negative ion production from a surface ion source, as it was done in the astatine experiment, is limited to elements with EA higher than the work function of the surface ionizer. LaB_6 as ionizer material was previously used for accessing negative ions at ISOLDE, which is not sufficient for the production of Po^-. In this experiment, a Po^- beam was produced from Po^+ beam via sequential double electron capture in a charge exchange cell (CEC) of the CRIS beamline.

As an example, Fig. 1 presents a broadband LPT scan of $^{210}Po^-$. Additional high-resolution scans with a laser linewidth of 20 MHz are currently being analyzed. The in-flight negative ion beam production with CEC opens up EA measurements for a variety of low-EA radioactive ions, while it additionally eliminates the need to change polarities in the ISOLDE beamlines before/after negative ion experiments.

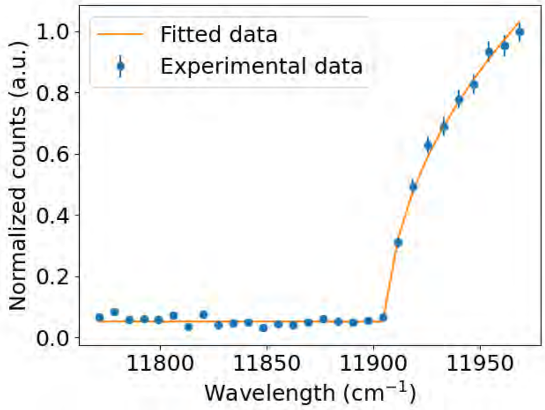

Figure 1: Broadband scan of the photodetachment threshold of Po^-, including a Wigner's law fit for EA determination.

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`https://isolde-cris.web.cern.ch/`

Advancing laser spectroscopy of light nuclei at COLLAPS

Ronaldo Méndez Hernández
for the COLLAPS collaboration

Nuclear properties of light nuclei are central to our understanding of the atomic nucleus, as they provide a stepping stone toward describing more complex nuclear many-body systems. Because the number of valence nucleons is often comparable to the size of the core, correlations are strongly enhanced, making these nuclei an ideal laboratory for studying strongly correlated quantum systems. Shell evolution, nuclear halos and islands of inversion are striking examples of the rich physics found in this region.

Although exotic isotopes of light elements are produced at ISOLDE, extending collinear laser spectroscopy (CLS) to elements such as fluorine and oxygen has remained challenging for several reasons. First, ground-state atomic and ionic transitions often lie in the vacuum-ultraviolet region, beyond the reach of existing narrow-linewidth cw lasers. Second, trapping and manipulating these light species remains technically challenging. Third, these elements are mainly produced as molecular compounds, such as AlF_3 and O_2, which hinder CLS due to reduced beam purity and the appearance of molecular sidebands.

Last year, efforts at COLLAPS focused on addressing these limitations. As a first step, the new LIAF (Laser-Induced Atomic Fluorescence and Ionization) setup, was designed, built, and commissioned. This setup combines conventional CLS with state-selective collisional ionization in a gas cell. This method replaces photon counting with efficient ion counting while preserving the use of cw lasers. By detecting ions and/or the decay of the isotope of interest, the laser stray light –often the dominant background in conventional CLS– is effectively removed. Importantly, this approach allows measurements on a continuous beam, overcoming one of the main challenges mentioned above.

Proof-of-principle measurements with LIAF were carried out on a continuous F^+ beam from an ECR ion source. Fluorine ($Z = 9$) was chosen as a key case in the light-mass region, where proton halos, α-clustering, and the emergence of new magic numbers are expected. Three laser transitions (690, 685, and 677 nm) were tested, and key parameters such as buffer gas, laser power, and gas-target pressure were optimized to maximize the reionization signal. These measurements successfully resolved the hyperfine structure of stable ^{19}F ($I = \frac{1}{2}$), see Fig. 1. The setup is now fully prepared to study exotic fluorine isotopes at ISOLDE after LS3, where production rates of up to 8000 ions/s are expected for the proton-halo nucleus ^{17}F.

As a second step, efforts addressed the formation of molecular species, paving the way for the first CLS measurements of exotic oxygen isotopes. To this end, the gas target of the LIAF setup was used to dissociate CO^+ molecules and efficiently produce O^+ beams. First CLS measurements in atomic ^{16}O were successfully performed both on oxygen extracted directly from the source and after molecular breakup. Ongoing systematic studies aim to improve the spectral line shape.

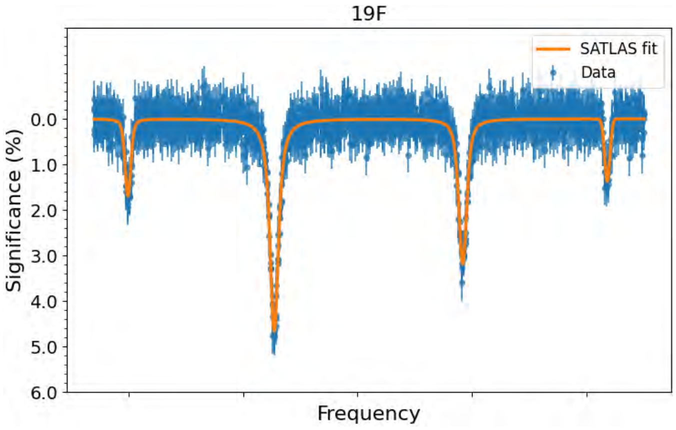

Figure 1: Hyperfine spectrum of ^{19}F measured with LIAF

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https://collaps.web.cern.ch

Online Cd measurements with the high-voltage MIRACLS setup

Anthony Roitman for the MIRACLS collaboration

The Multi-Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) is designed to increase the experimental sensitivity of fluorescence-based collinear laser spectroscopy (CLS) by exploiting a Multi-Reflection Time-of-Flight (MR-ToF) device. This instrument utilizes two electrostatic ion mirrors to reflect ion bunches back and forth for several thousands of revolutions. While the ions are trapped between the mirrors, a laser beam is superimposed collinearly with the MR-ToF axis, allowing photon-ion interactions to take place during the entire ion storage time. This typically lasts tens of milliseconds compared to only a few microseconds in conventional, single-passage CLS. As a result, the CLS sensitivity is largely improved, opening a path to study exotic radionuclides with very low production yields [1].

After the successful demonstration of the MIRACLS concept in a low-energy, offline apparatus, a new setup has been constructed which is now coupled to ISOLDE's online facility and operates at higher ion beam energies for enhanced CLS resolution.

As reported in last year's newsletter, the first MIRACLS-based online measurements were performed on neutron-rich Mg isotopes in 2024, accessing previously unexplored charge radii in the $N = 20$ island of inversion. Building on these successes, in August 2025, MIRACLS conducted a campaign to measure the charge radii and electromagnetic moments of neutron-deficient Cd isotopes. Laser spectroscopy was first performed via an offline Cd ion source, and then with radioactive ions delivered from ISOLDE. Results were compared with CLS measurements on Cd radioisotopes previously carried out by the COLLAPS collaboration [2], while also extending laser-spectroscopic data to previously unexplored neutron-deficient Cd isotopes. An example of a Cd resonance obtained by MIRACLS is shown in Fig. 1.

The new MIRACLS data extends our knowledge of the nuclear structure of neutron-deficient Cd isotopes, serving as an important benchmark for new techniques in modern nuclear theory, such as the latest advances in density functional theory (DFT), which includes the development of an improved Fayans functional that has recently been very successful in predicting nuclear charge radii across a wide mass range [3, 4].

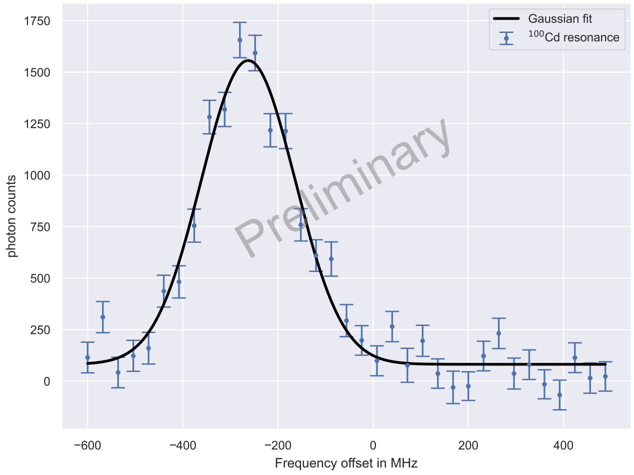

Figure 1: An example of a ^{100}Cd resonance measured by MIRACLS.

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https://miracls.web.cern.ch

Precision mass measurement of n-deficient ^{96,97,98}Cd isotopes and n-rich ^{49}Ar

Results of the experiments IS745 and IS766

Christoph Schweiger for the ISOLTRAP collaboration

ISOLTRAP [1] is a multi-ion-trap mass spectrometer performing precision mass measurements of exotic radionuclides at the ISOLDE facility at CERN. It consists of a radiofrequency quadrupole cooler and buncher (RFQ-CB) for capture and buffer gas cooling of the radionuclides followed by a multi-reflection time-of-flight mass spectrometer (MR-ToF MS) that can also be employed as a mass separator for isobaric purification. Subsequently, the purified beam can be introduced to a tandem Penning-trap mass spectrometer to reach the highest precisions if required.

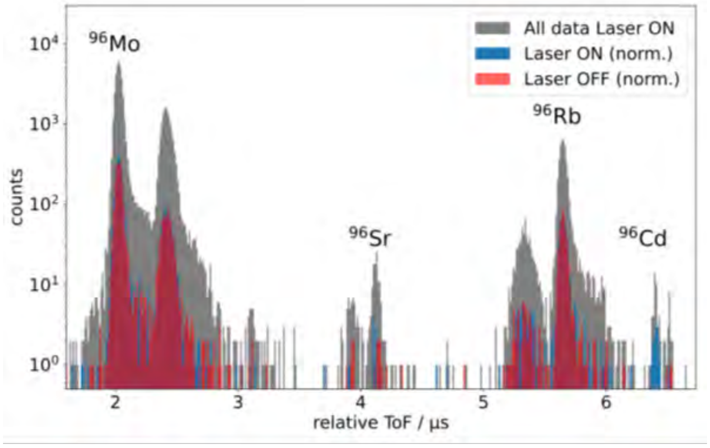

Figure 1: Time-of-flight spectrum of the A = 96 beam from the MR-ToF MS during the IS745 run in 2025. On the right side of the spectrum, with a clear correlation of the laser being on or off, is the peak of ^{96}Cd [2]

Following the successful test of a LaC_x-target with improved heat shielding in 2023 where the masses of ^{98}Cd and ^{97}Cd including the 25/2+ spin-gap isomer ^{97n}Cd have been measured, the up to fivefold higher yields indicated the feasibility for a mass measurement of ^{96}Cd which was performed within IS745 in 2025. For this measurement temporal changes of the temperature within the ISOLDE hall were suppressed with a temperature stabilization system. The resulting ToF spectrum for the A = 96 beam is shown in Fig. 1, where ^{96}Cd is visible on the very right side of the spectrum following the peak of ^{96}Rb. In total, about 41 counts were recorded in the 3.5 day run during which, for a significant amount of the time, an increased proton current of 2.5 μA was taken onto the target. This measurement marks the lowest yield mass measurement that was so far performed at ISOLTRAP and shows the significant improvements in stability and sensitivity that were made over the past years [2].

A further substantial increase of the sensitivity is achieved by the addition of the miniRFQ, a small RFQ-CB originally developed at the MIRACLS setup, that was adapted to implement mass-selective re-trapping at ISOLTRAP. The miniRFQ was successfully deployed for the first online experiment in 2025 during IS766 for a measurement of the mass of ^{49}Ar [2]. This measurement consisted of an initial mass separation followed by a mass selective ejection and subsequent capture and cooling in the miniRFQ before the purified and re-bunched ions are injected back into the MR-ToF for the final precision mass measurement with an efficiency of about 50% compared to the direct mass measurement in the MR-ToF MS. During the online experiment a contamination suppression factor of $3 \cdot 10^5$ was reached ultimately limited by the space-charge capability of the main RFQ-CB. The latter will be upgraded during Long Shutdown 3 where also extended upgrades of the MR-ToF MS as well as of the Penning traps are planned. In addition, the current wooden ISOLTRAP platform will be replaced by an aluminium structure.

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https://isoltrap.web.cern.ch/

Decay studies

High precision β spectrum shapes: off-line experiments at WISArD

Charlotte Knapen for the WISArD collaboration

The WISArD experiment is most well known for its on-line measurements of ^{32}Ar, with the aim of determining the $\beta - \nu$ angular correlation and the Fierz interference term (i.e. searching physics beyond the Standard Model) [1, 2]. The WISArD set-up is also used for off-line experiments, namely high precision measurements of β spectrum shapes. The physics goal of these experiments is to determine the Weak Magnetism form factor, a strong-interaction induced effect in the weak interaction. If sufficiently high precision is reached, the Fierz interference term can also be probed.

The main strength of our experimental set-up is the ability to identify backscattered electrons through two face-to-face detectors placed inside the high magnetic field of the WISArD set-up. The proof of principle experiment was conducted in 2020 using plastic scintillators and SiPM's, this work resulted in a PhD thesis [3]. In the years since then the experimental set-up has been upgraded, mainly through the replacement of the scintillators by Si(Li) detectors, improving the energy resolution by approximately two orders of magnitude and energy threshold by approximately one order of magnitude.

Preparatory work in Leuven and Bordeaux led to the development of a cooling system combining a glycol cooler and a thermoelectric cooler (i.e. a Peltier element) capable of cooling the detectors down to -70℃, a temperature at which the energy resolution of the Si(Li) detectors is comparable to that at liquid nitrogen temperature.

The upgraded experimental set-up was first installed and tested in ISOLDE in September 2025. For this first test, only a ^{207}Bi calibration source was measured and the magnet was not turned on. Following this successful test, the next experiment was carried out in January/February 2026. For this experiment the magnetic field was turned on up to 8 T and a β spectrum source was measured. In total around 40 hours of ^{114}In data was collected. A time coincidence window can be applied to measurements taken in a high magnetic field, allowing backscattered electrons to be filtered out of the energy spectrum, as is shown in Fig. 1. Here, the effect of the filter is most visible for the conversion electron peaks around 200 keV, where the low-energy step of the peaks has noticeably decreased.

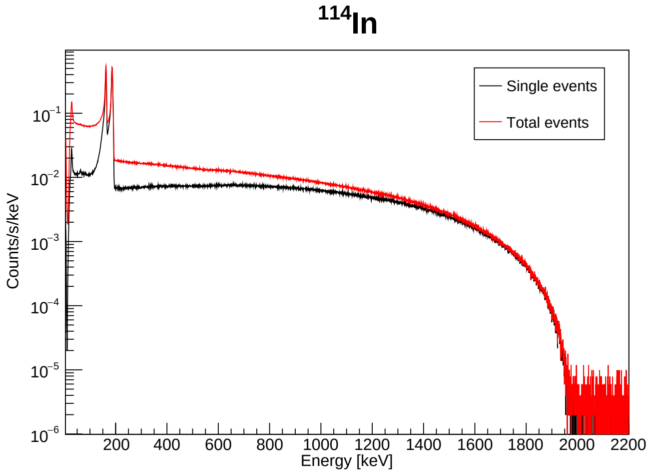

Figure 1: Comparison of the total events in one detector versus those where no event was registered in the other detector, i.e. the "single events". This shows how the face-to-face detector set-up can filter out backscattered electrons.

For our next experiment we aim to measure the β spectrum shape of ^{32}P, in addition to measuring ^{114}In again. In the meantime, we are working on further improving our experimental set-up and analysing the data from the last experiment.

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https://isolde.cern/wisard

Implementation of new decay spectroscopy techniques at IDS: γ–γ angular correlations and internal conversion electron measurements

Results of experiment IS709

J. Sánchez-Prieto, D. Movilla-Quintero, B. Olaizola, J.A. Briz,
J. Cubiss, A. Illana, R. Lica, V. Vedia for the IDS collaboration

The ISOLDE Decay Station (IDS) provides a versatile platform for high-precision decay spectroscopy, enabling detailed studies of nuclear structure through a combination of complementary experimental techniques. A key recent development is the ability to perform combined γ–γ angular correlation measurements and internal conversion electron spectroscopy, significantly expanding the range of accessible observables within a single experiment.

These capabilities were demonstrated in the IS709 experiment, which served to establish and validate new experimental approaches at IDS. The setup was equipped with an array of 13 HPGe Clover detectors positioned at preddefined angles, enabling precise γ–γ angular correlation measurements. This technique allows the determination of transition multipolarities and provides strong constraints on spin and parity assignments [1]. The performance of the angular correlation analysis is illustrated using the well-known $4^+ \rightarrow 2^+ \rightarrow 0^+$ cascade populated in the decay of ^{60}Co, demonstrating the sensitivity of the IDS Clover array to transition multipolarities, see Figure 1.

Another significant development was the integration of the SPEDE spectrometer [2] within the IDS setup for the detection of internal conversion electrons, including the development of a new chamber and a liquid ethanol–based cooling system. This upgrade enabled the determination of $\rho^2(E0)$, when combined with branching ratios and lifetime information. Moreover, conversion coefficients can be extracted, which are sensitive to the transition mixing ratio δ. Figure 2 shows the spectrum of conversion electrons emitted after the decay of ^{207}Bi as an example of electron spectroscopy measurements at IDS.

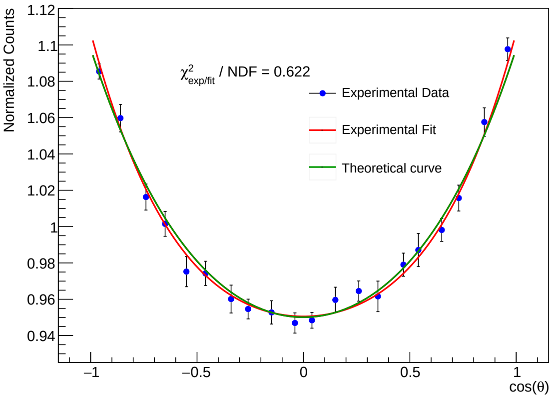

Figure 1: γ–γ angular correlation measured for the decay of ^{60}Co ($4^+ \rightarrow 2^+ \rightarrow 0^+$ cascade). The data are shown without correction for solid angle effects.

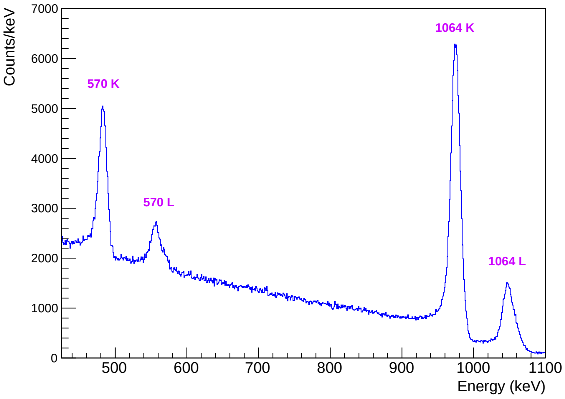

Figure 2: Internal conversion electron spectrum of ^{207}Bi measured with the SPEDE spectrometer. The FWHM is 13 keV at 481.7 keV and 15 keV at 975.7 keV.

Our next goal is to combine γ–γ angular correlations, internal conversion electron spectroscopy, and fast-timing measurements in a single experiment to extract electromagnetic transition rates and enable a comprehensive characterization of nuclear states, while demonstrating the flexibility and recent performance improvements of the IDS setup.

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https://isolde-ids.web.cern.ch

Decay spectroscopy of the ^{225}Ac decay chain at IDS

Results of experiment IS741

Jana Aelbrechts, Stergiani Marina Vogiatzi
for the IDS collaboration

Over the past decades, actinium-225 has attracted significant interest in nuclear medicine for its potential in treating metastasized tumors in targeted alpha therapy [1]. Before widespread clinical use is possible, remaining challenges must be addressed. For both logistic and medical purposes, improved nuclear data along the entire ^{225}Ac decay chain (Fig. 1) are required [2].

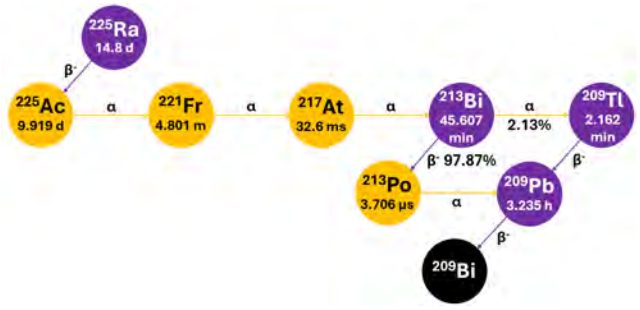

Figure 1: The ^{225}Ac decay chain with indicated half-lives and branching ratios as obtained from literature [3].

The IS741 collaboration aims to determine the decay properties along the ^{225}Ac decay sequence by separately implanting ^{225}Ac, ^{221}Fr, ^{213}Bi and ^{209}Tl in dedicated beam times for the first time. All beams were produced by proton irradiation of UC$_x$ targets at ISOLDE. The ISOLDE Decay Station (IDS) was employed, utilizing its tape station for beam implantations.

In December 2024, the decays following the implantations of laser ionized ^{225}Ac and surface ionized ^{221}Fr were studied using a combination of twelve High Purity Germanium (HPGe) clovers for γ-ray detection, and Si pin diodes and plastic scintillators for charged particle detection. Particular focus was placed on measuring the angular distribution of coincident γ rays, and therefore, the clovers were positioned at predefined angles around the implantation point.

In the following year (Dec. 2025), the ^{213}Bi and ^{209}Tl decays were studied with the last protons before LS3. For ^{213}Bi, the isobaric ^{213}Fr contamination was suppressed with a LIST. ^{209}Tl was laser ionized with protons off. The setup was upgraded to enable simultaneous implantation and decay measurements.

The IS741 experimental campaigns have been successful, yielding the majority of the anticipated data. Consequently, the experimental phase of IS741 can be considered complete. Analysis on the collected data is underway to establish branching ratios, γ-ray intensities, half-lives, level schemes and to study angular distributions in ^{209}Tl and ^{213}Bi. Figure 2 shows a γ-ray energy spectrum, gated on the 293 keV transition in ^{213}Bi, obtained in five hours, while decay data were collected for 38 days following the ^{225}Ac implantations.

The success of the IS741 experiments would not have been possible without the extensive efforts of the ISOLDE and RILIS teams, which we acknowledge here.

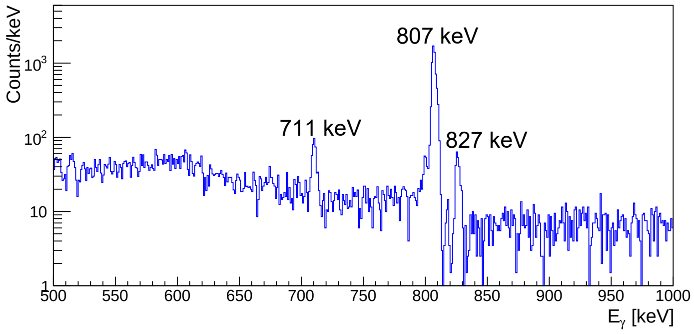

Figure 2: The γ-ray energy spectrum of the ^{225}Ac decay, gated on the 293 keV transition in ^{213}Bi. The data were acquired during five hours of measurement, illustrating the high statistical quality of the coincidence peaks in the full data set.

References

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`https://isolde-ids.web.cern.ch`

Probing Nuclear Structure in the Lead Region - Study of ^{212,213g,m}Bi by Decay and Laser Spectroscopy

Results of experiment IS747

Zixuan Yue (University of York)
on behalf of York-Edinburgh-RILIS-IDS-ISOLTRAP collaboration

Sharp discontinuities in changes in nuclear mean-square charge radii ($\delta\langle r^2\rangle$) crossing neutron shell closures provide important benchmarks for nuclear structure models. In the lead region (Z = 82), this kink is systematically observed, yet its microscopic origin remains unclear. In particular, the contribution of neutron single-particle states is still debated [1, 2, 3], especially whether the greater spatial overlap between protons and a neutron in the $1i_{11/2}$ orbital, relative to the $2g_{9/2}$ state, is the dominant factor responsible for the increase in gradient in $\delta\langle r^2\rangle$. Therefore, experimental data on ground and isomeric states are essential for clarifying what role the $\nu 1i_{11/2}$ orbital plays.

Laser and decay spectroscopy of ^{212,213g,m}Bi were performed at the ISOLDE Decay Station (IDS), together with the resonance ionisation laser ion source (RILIS), during the IS747 run in December 2025. By combining in-source laser spectroscopy with the high-efficiency decay tagging method, a high-sensitivity approach was used to determine the electromagnetic moments and $\delta\langle r^2\rangle$ values. The IDS setup consisted of 13 clover detectors at the implantation position, achieving a maximum γ-ray efficiency of 23.5% at 75 keV, alongside three plastic scintillators with a β-tagging efficiency of up to 70% (Fig. 1 (a)). A tape system moved the implanted isotopes to a secondary decay position to remove contamination from long-lived daughter products. A new decay position chamber designed at Edinburgh was placed at this second position, surrounded by three clover detectors (Fig. 1 (b) and (c)). A plastic scintillator for β tagging was placed inside the chamber, along with five silicon PIN diodes for detecting α decays of short-lived polonium daughters after the β-decay of bismuth.

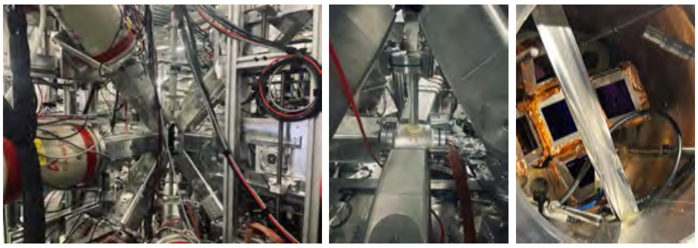
(a) (b) (c)

Figure 1: Experimental layout of the IDS during the IS747 campaign. (a) implantation position; (b) decay position; (c) close-up of the silicon array inside at the decay position.

The selectivity of laser spectroscopy was exploited to produce isotopically pure ion beams, enabling clean decay studies. The α-decay of the daughters of the low-yield isomers ^{212m1}Bi (I^π = (8$^-$), (9$^-$)) and ^{212m2}Bi (I^π = (18$^-$)) monitored at the decay position (see Fig. 2) allowed hyperfine structure measurements and hence the determination of the magnetic moment of the high-spin isomer ^{212m2}Bi for the first time.

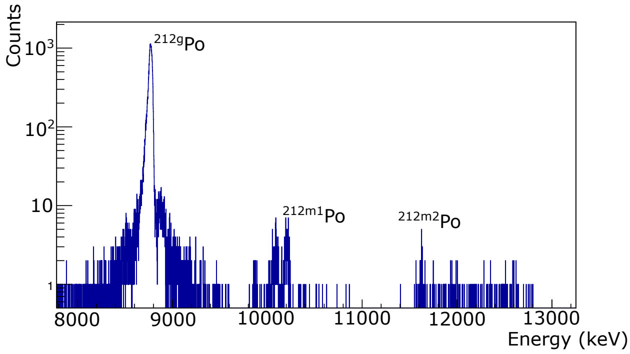

Figure 2: Singles α-energy spectrum acquired during the ^{212}Bi laser scan. Peaks correspond to the α decay of the ^{212}Po ground state and its two high-spin isomeric states.

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In-source laser and decay spectroscopy of pure ^{209,210}Hg beams obtained with the cold quartz transfer line

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Results of experiment IS756

J. Wilson
On behalf of the York-Edinburgh-RILIS-IDS collaboration

Nuclear shell structures can heavily influence fundamental ground and isomeric state properties across the nuclear chart. Some of the most striking effects are observed when crossing magic numbers of protons and neutrons, where, for example, discontinuities in separation energies and charge radii are seen. One of the most notable examples is the kink in nuclear charge-radii when crossing the $N = 126$ closure, which has been explored in the Bi, Pb, Tl and Hg isotopes [1, 2]. Further, the relatively simple structures of nuclei near doubly-magic nuclei such as ^{208}Pb makes them ideal testing grounds for state-of-the-art theory such as large-scale shell model calculations.

Confirmation of the kink in Hg was performed at ISOLDE, with the first laser spectroscopy measurements of ^{207,208}Hg using molten Pb targets [3], which cannot be used to produce heavier isotopes as ^{208}Pb does not contain enough neutrons. Therefore, to produce more neutron-rich Hg isotopes a heavier mass target, such as uranium carbide (UC_x), is required. However, the high operating temperatures of UC_x targets alone leads to overwhelming isobaric contamination from surface-ionised Fr isotopes.

IS756 sought to extend measurements to heavier Hg isotopes, further exploring the charge radii and the single-particle structures south-east of ^{208}Pb. This was done using a UC_x target coupled to a temperature-controlled quartz line, which suppressed isobaric Fr contamination by several orders of magnitude. In-source laser spectroscopy and ionisation were performed using RILIS, with beams delivered to the ISOLDE Decay Station (IDS) for decay-tagged hyperfine structure scans and decay measurements of ^{209,210}Hg. The extracted beams were implanted into a movable tape system, which removed long-lived activity from the IDS implantation position to a secondary "decay" point for spectroscopy of long-lived daughter activity. The implantation point was surrounded by eight High-Purity Germanium (HPGe) detectors and three plastic scintillators for β tagging, whilst two HPGe and two plastic scintillators were used at the decay position. Both positions achieving absolute γ-detection efficiencies of $\sim$ 24% at 80 keV. Figure 1 compares the β-tagged, γ-ray energy spectra for ^{209,210}Hg recorded at the implantation position. The experiment succeeded in obtaining hyperfine structure scans and decay data for both isotopes, with publications currently in preparation for both the decay and laser spectroscopy results.

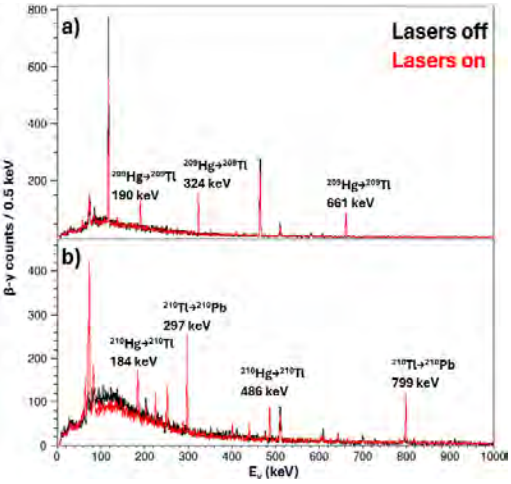

Figure 1: Laser-on shown in red versus laser-off in black β-γ coincidence spectra for a) ^{209}Hg and b) ^{210}Hg

References

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Shape Coexistence Beyond the N = 104 Midshell - Study of ^{180}Au (Z=79, N=101) by Decay Spectroscopy

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Results of experiment IS756

Anthony McFarlane (University of York)
for the York-Edinburgh-RILIS-IDS collaboration

The late 1970s and early 1980s saw the landmark discovery of shape staggering and coexistence in neutron-deficient Hg and Au nuclides situated near the N = 104 mid-shell [1]. Recent renewed interest in the gold chain has been driven by improvements in production techniques and laser-spectroscopy measurements of mean-squared charge radii ($\delta\langle r^2\rangle$) that indicate structural deformation. Beyond the deformed plateau (A = 186–180), this new data reveals a sudden jump back toward near-sphericity beginning with ^{179}Au (N = 100) [2]. This makes ^{180}Au an interesting case study, as the last member of the deformed ground state plateau, and possibly expressing both deformed and spherical states in close proximity. In this context, β decay provides a sensitive probe of nuclear structure, owing to its dependence on the structural differences between the mother nucleus and the populated states. β decay of ^{180}Hg was previously studied at ISOLDE in 1977 [3], producing singles spectra, but no decay scheme was proposed. A new precision study has been conducted with higher production yields and detection efficiency. ^{180}Hg nuclei were produced in proton-induced spallation reaction using a UC$_x$ target, selective ionisation (by RILIS), mass separation and implantation into a movable tape of the ISOLDE Decay Station (IDS), where their decays were studied. Surrounding the implantation position were 8 high-purity germanium (HPGe) clover detectors for γ-ray spectroscopy and accompanying plastic scintillators for β-particle detection. A maximum absolute γ-detection efficiency of 23% at 100 keV (without addback) for implantation position. After 7 s the tape was moved to remove activity of daughter products. A further two clovers and plastic scintillators were placed at a secondary decay position, allowing for the study of long-lived daughter decays. Approximately one hour of decay data was collected. This significantly improves the statistics over the 1977 study. A decay scheme based on prompt β-γ-γ coincidences has been constructed for the first time. The identification of transitions in the daughter ^{180}Au is supported by the spectra in Fig. 1, which compares the β-tagged (a), and γ-γ coincidence gate on the 301 keV line (b). Several low-lying excited states were identified, including a dominant cascade involving 301, 126, 52, and 27 keV γ-ray transitions. This final 27 keV transition to the ground state reveals a new isomer with a lifetime of roughly 0.5 μs. Results to be published [4].

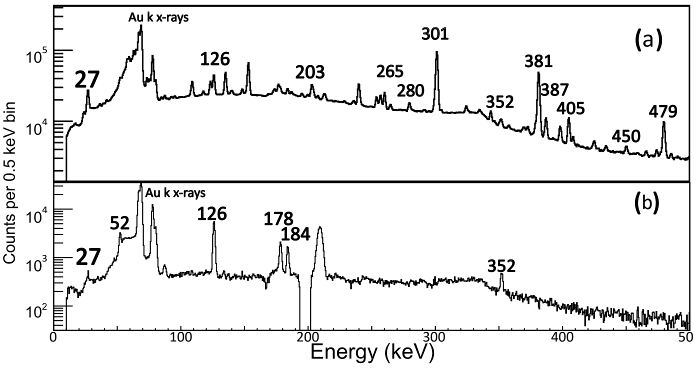

Figure 1: (a) β-tagged, and (b) γ-γ coincidence spectra for the ^{180}*Hg* decay. The coincidence spectrum (b) is gated on the 301 keV transition using a ±200 ns time window. Key transitions and coincidences are indicated by energy labels for each spectrum.

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Production of intense, high-purity beams of neutron-rich Ga isotopes at ISOLDE

Results of experiment IS771

P. González-Tarrío Vicente, L. M. Fraile, J. Benito, A. Illana,
J. A. Briz, et al. for the IS771 and IDS collaborations

The IS771 experiment aimed to study the nuclear structure of neutron-rich Ge isotopes above the $N = 50$ shell closure through β-decay and β-delayed neutron emission of neutron-rich Ga isotopes [1]. The purpose was to gain insight into the evolution of shell structure and the onset of collectivity in the region around ^{78}Ni, which exhibits a rapid shape evolution from spherical to deformed nuclei [2]. The high yields of Ga isotopes were achieved using a UC$_x$ target with a proton-to-neutron converter and the high-efficiency RILIS technique for selective ionization. The setup included 40 HPGe crystals in clover configuration combined with two LaBr$_3$ scintillators and three fast-beta detectors for fast-timing measurements. The experimental yields obtained during this campaign (see Fig. 1) were consistent with previous data from 2023, as well as the PSB database [3], which further validated the robustness of the setup and the purity of the neutron-rich Ga beams.

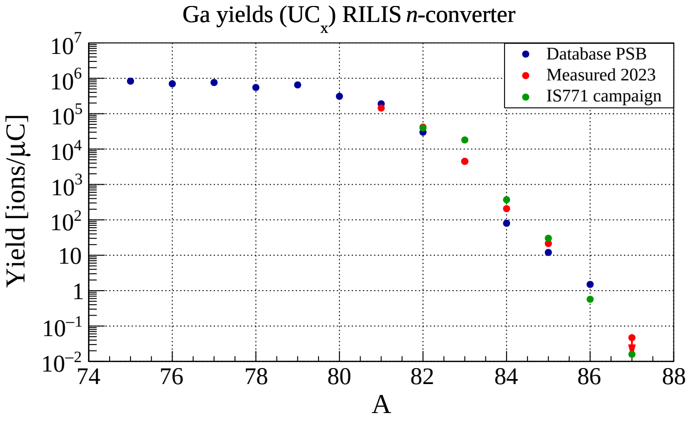

Figure 1: Yields for Ga isotopes between $A = 75 - 87$. Blue dots correspond to the PSB database [3], red ones from the previous data from 2023, and green ones belong to the IS771 campaign.

The experiment enabled the detailed study of excited states in ^{85,84}Ge, populated through the β decay and β-delayed neutron emission of ^{85}Ga, respectively. Figure 2 shows how β-gated combined with time reference conditions relative to the proton impact makes it possible to assign transitions in ^{85,84}Ge. The use of γ-γ coincidence techniques and fast-timing methods will allow us to expand the level schemes and measure excited-state lifetimes, providing new information on the structure of these exotic nuclei in the vicinity of ^{78}Ni.

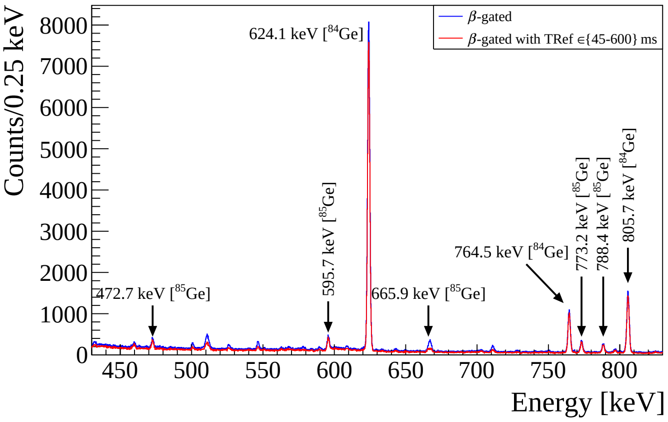

Figure 2: β-gated γ-ray spectra from ^{85}Ga decay without time reference conditions after the proton impact (TRef) in blue and with TRef $\in \{45, 600\}$ ms in red.

The IS771 collaboration thanks the ISOLDE technical teams and the ISOLDE and IDS Collaborations, and acknowledges support from EU's Horizon Europe research programme under EURO-LABS (grant agreement no. 101057511).

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Shape coexistence in ^{185}Au studied with the TATRA spectrometer at ISOLDE

Results of experiment IS521

Matúš Sedlák, Martin Venhart, Andrej Herzáň
for the IS521 collaboration

The IS521 experiment, led by the team from the Institute of Physics of the Slovak Academy of Sciences, marks another milestone in the study of very neutron-deficient odd-mass Au isotopes. Following successful measurements in 2014 [1] and 2016 [2], a 7-day experiment was carried out in October 2025. The experiment, aimed at studying ^{185}Au, employed the TATRA spectrometer [3] installed at the LA1 beamline of the ISOLDE facility. The ^{185}Au nuclei were populated via the β-decay of ^{185}Hg delivered by the HRS separator.

The TATRA spectrometer uses a metallic tape to transport radioactive samples. At the measurement position, three standard coaxial HPGe detectors and a single Broad Energy Germanium (BEGe) detector were arranged around the sample for γ-ray detection. A windowless LN$_2$-cooled Si(Li) detector for conversion electrons was placed in close proximity to the sample under vacuum.

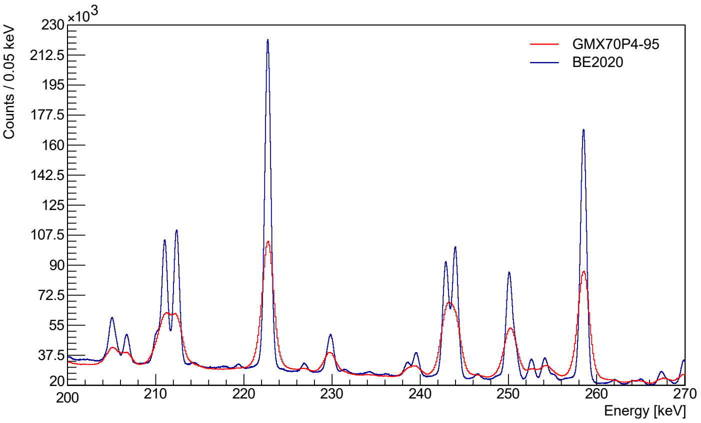

Figure 1: Comparison of spectra measured with the BEGe BE2020 (blue) and a coaxial HPGe detector (red).

Despite several technical difficulties during the campaign, the accumulated statistics significantly exceed those of the previous work by C.D. Papanicolopulos et al. [4], by a factor of 14 for γ–γ coincidence events and a factor of 31 for γ–e$^-$ coincidences. One of the main goals of the experiment is the investigation of electric monopole ($E0$) transitions and their placement within the level scheme. The precision of the transition energies will be greatly improved thanks to the use of the BEGe BE2020 detector, as demonstrated in Ref. [5]. This will improve the level scheme of ^{185}Au and enlarge the systematics of intruder and "normal" nuclear configurations of odd-mass Au isotopes. A comparison between a modern large-volume n-type coaxial HPGe detector (red line) and the BEGe BE2020 detector (blue line) is shown in Fig. 1. However, the analysis of odd-mass nuclei remains particularly challenging due to the high level density and the complexity of the measured spectra, as illustrated in Fig. 2. These results provide a solid basis for a detailed spectroscopic analysis and future systematic studies of shape coexistence in neutron-deficient Au isotopes.

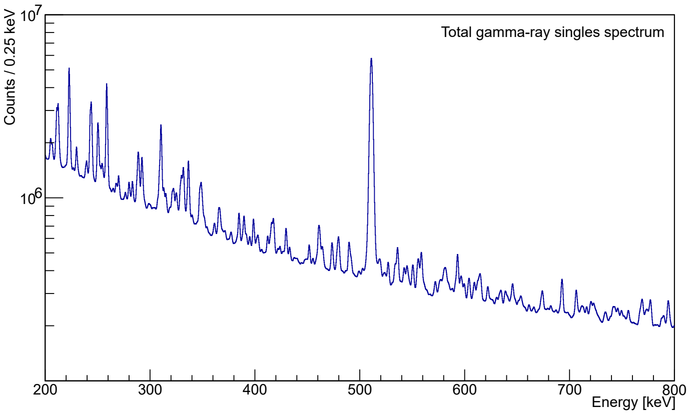

Figure 2: Total singles γ spectrum summed over all four employed γ-ray detectors.

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Studies with post-accelerated beams

Single-neutron transfer on A=27 beams using ISS

Sean J Freeman on behalf of the IS710 collaboration

Following our previous studies of ^{28}Mg, we have used the ISOLDE Solenoidal Spectrometer (ISS) to study (d, p) reactions on a $A = 27$ beam at 9.77 MeV/u to study single-particle strengths in nuclei on the shores of the island of inversion. The beam was used to bombard a deuterated polyethylene target within a 2.1-T field in ISS. Protons at backward laboratory angles were measured in a position-sensitive double-sided silicon array, and the proton energy and position were used to reconstruct the excitation energy in the residual nucleus. Downstream, a $E\Delta E$ silicon telescope was used to identify heavy ions recoiling from the reactions. Finally, a double-sided annular silicon detector was used as a luminosity detector. Analysis of the timing between monitor and recoil detectors indicated the presence of both deuterons and protons scattered at different centre-of-mass angles, but with very similar energies. The proton contamination is likely to arise from the use of xylene as a solvent during the target production. The separation using the timing was sufficient to separate the two groups.

Typical excitation energy spectra are shown in figure Fig. 1 for the ^{28}Mg and ^{28}Na residual nuclei. The experiment was optimised for the latter reaction, so the acceptance for the lower lying states in ^{28}Mg is restricted. Although data were collected concurrently on ^{28}Al, the results did not extend extant data using stable beams. The measured reaction cross sections were used to deduce spectroscopic strengths, initially using standard DWBA techniques. These have been compared to the results of shell-model calculations using effective interactions specifically developed to describe nuclei in the region of inversion.

The general picture of the populated negative-parity states is reasonably well described by calculations using the SDPF-MU and FSU interactions. Both of these interactions base their *sd*-shell forces on different formulations of the USD interaction, the former using the original USD interaction and the latter a newer variant, USDB. These reproduce the positive-parity states well in ^{28}Mg.

However, in the case of ^{28}Na, the positive-parity strength distributions turn out to be better described by a calculation using a third version, USDA. This sensitivity appears to be associated with the importance of matrix elements in the odd-odd system that were less well constrained by the fits on energy levels of nuclei closer to stability that were used to develop the *sd* shell effective interactions.

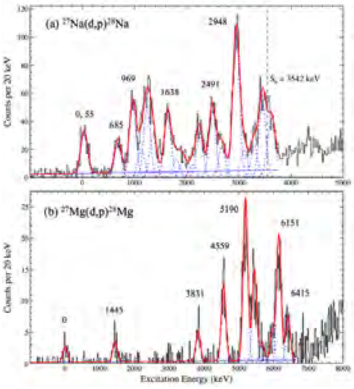

Figure 1: Excitation energy spectra for excited states populated in the (a) ^{27}Na(d,p) and (b) ^{27}Mg(d,p) reactions.

We have been collaborating with colleagues from Vilnius University who have applied rigorous Faddeev scattering theory to the calculation of transfer cross sections for the reactions used here. An initial reanalysis of the current data using these new calculations validates the approximations made in the DWBA approach to deal with the three-body reaction problem.

More details will be available in an upcoming publication.

Fission studies at ISS

Results of experiment IS739

Maria Vittoria Managlia for the IS739 ISS collaboration

Transfer–induced fission of a radioactive beam has been studied for the first time at the ISOLDE Solenoidal Spectrometer (ISS) via (d, pF) reactions. IS739, performed in July 2025, builds on a pioneering stable beam (d,pF) experiment at ANL using the HELIOS setup [1]. A novel compact setup was designed to maximise the detection efficiency for fission fragments in coincidence with transfer-like protons in the 2 T solenoidal field. The detection system comprises an on-axis position-sensitive silicon array — protons follow helical trajectories in the magnetic field and return to the central axis of the magnet, where they are detected. Fission fragments are measured using annular double-sided silicon detectors (DSSDs) in a ΔE–E telescope configuration, while gamma rays are recorded by an array of 28 $CeBr_3$ crystals from the SpecMAT setup [2]. Four position–sensitive silicon detectors monitor the beam luminosity by detecting deuterons scattered from the target. A CAD drawing of the full setup installed inside ISS is shown in Fig. 1.

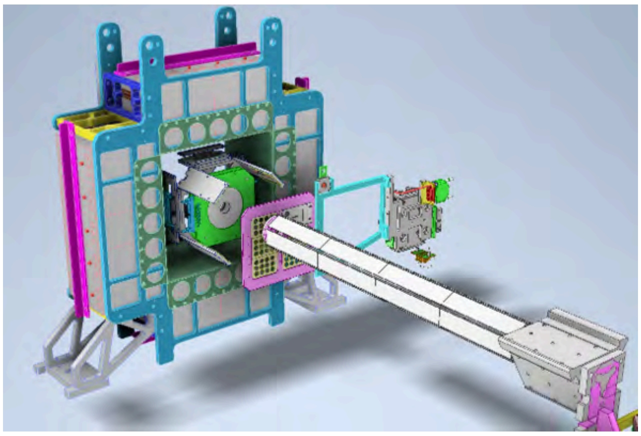

Figure 1: Schematic illustration of the setup used inside the ISS magnet, beam enters the setup from the right.

The setup was commissioned using a ^{22}Ne stable beam at 6 MeV/u in June 2025, demonstrating good resolution and performance of all detectors.

Experiment IS739, aimed at studying transfer-induced fission of ^{232}U at 7.34 MeV/u on a CD_2 target. Figure 2 shows the ΔE–E correlation matrix obtained during the experiment, where bands corresponding to different fission fragment charges are resolved.

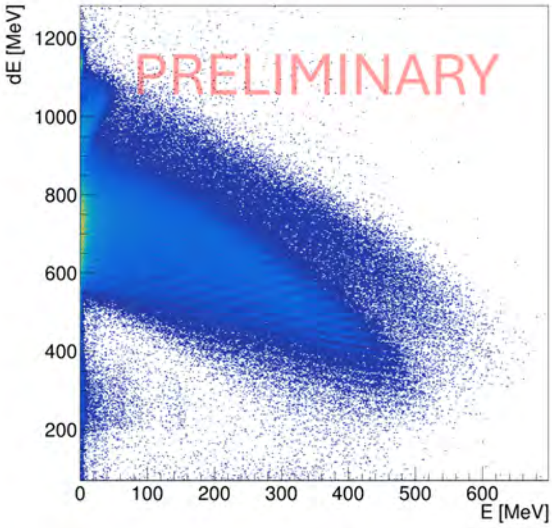

Figure 2: Preliminary ΔE–E correlation matrix measured with the annular DSSD telescope, showing the charge identification of fission fragments produced in ^{232}U reactions on a CD_2 target.

The ultimate goal of IS739 is to extract the fission probability P_f of ^{233}U as a function of its excitation energy E*, in coincidence with the charge distribution of fission fragments, the total released gamma-ray energy, and multiplicity. The latter observables are accessible via the $CeBr_3$ array, whose capability to detect prompt gamma rays has since been exploited by other experiments at ISS. Data analysis of IS739 is ongoing.

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LUME: new off–axis luminosity monitor at ISS

Detector development for experiment IS739

Anna Kawęcka for the IS739 ISS collaboration

For experiment IS739, a new luminosity monitor to extract absolute cross sections from (d,p) reactions was developed. The detector is based on four position-sensitive silicon detectors (PSDs), placed off axis and mounted parallel to the beam direction downstream of the target. Figure 1 shows the detectors mounted on their support structure.

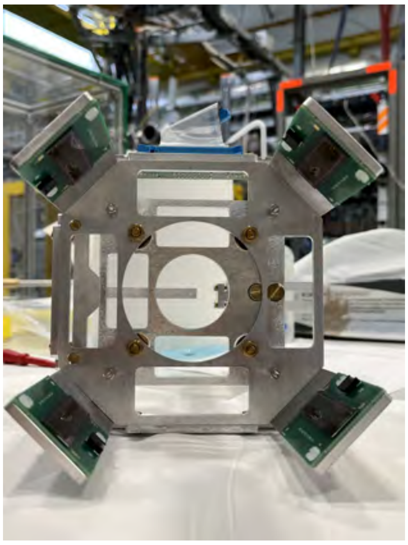

Figure 1: Photograph of a LUME detector holder with four LUME detectors mounted.

By using position-sensitive detectors, we are able to clearly distinguish different scattered particle species due to their unique kinematically determined energy-position patterns. In this way, carbon and deuterons from the CD_2 target (the standard target used in (d,p) reaction studies at the ISOLDE Solenoidal Spectrometer) can be identified.

Figure 2 shows data from stable beam commissioning of the IS739 experiment using ^{22}Ne beam on the left, and corresponding simulation results on the right. In both plots, the energy of the detected particle is plotted as a function of its hit position along the detector in relative units (where -1 and 1 correspond to the edges of the 5 cm long detector). It can be seen that the lines observed in the experimental spectrum correspond to elastically and inelastically scattered deuterons from the target, as well as elastically scattered protons, presumably from impurities in the target.

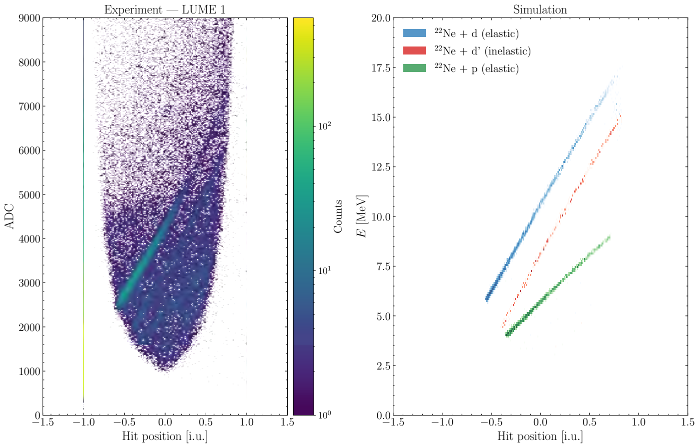

Figure 2: Comparison of experimental data and simulation for the LUME detector response. Left: Energy versus relative hit position along the detector for particles detected during the stable-beam commissioning of the IS739 experiment using a ^{22}Ne beam. Right: Corresponding simulation results. Distinct bands correspond to elastically and inelastically scattered deuterons from the CD_2 target, as well as elastically scattered protons.

Using this type of detector in this geometry provides improved statistics compared to a previously used on-axis detector at ISS, and additionally allows for cleaner particle-species discrimination.

This new luminosity monitor is partly based on suggestions and experience from colleagues at Argonne National Laboratory, who also assisted with the bonding of the new LUME detectors [1].

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Advances of the Superconducting Recoil Separator (ISRS) multi-harmonic buncher for ISOLDE

Results of LoI INTC-I-228

I. Bustinduy, J.L. Muñoz, S. Varnasseri, K. Altenmüller, I. de los Bueis, D. Fernández-Cañoto, P. J. González, R. González, G. Harper, J. Martín, R. Miracoli, A. Zugazaga, I. Martel, MJG. Borge, T. Kurtukian-Nieto, J. Resta, O. Tengblad for the ISRS collaboration

The ISOLDE Superconducting Recoil Separator (ISRS) [1] requires a longer bunch spacing than that delivered by the HIE-ISOLDE linac. To meet this need, the ISRS programme[1] at ESS-Bilbao is developing a multi-harmonic buncher (MHB) operating at 10.128 MHz, one tenth of the linac frequency, so that the beam can be re-bunched while remaining synchronized with the downstream accelerator. The package delivered by ESS-Bilbao combines the buncher cavity, the RF generation and control chain, and a dedicated set of beam diagnostics. The MHB design evolved from early concepts [2] toward a wedge-electrode geometry optimized for the ISOLDE beam conditions [3]. The experimental line (see Fig. 1) also includes ACCT current transformers, a Faraday cup, a Wien filter (WF), and a fast Faraday cup (FFC) for bunch-length measurements [4]. To prepare beam commissioning, the ESS-Bilbao injector was configured to reproduce the reduced velocity required for the ISOLDE case, $\beta = 0.00328$. For this reason, in Bilbao, 10.094 keV H_2^+ was selected as the commissioning species to adjust the parameters to the intended ISOLDE application.

Once the MHB was designed [3] and manufactured, the Bilbao LEBT solenoids were tuned to enhance H_2^+ transmission and benchmarked the results against RF-Track [5] simulations, obtaining good agreement in the observed transmission peaks. Classical optimization approaches were first evaluated, followed by Bayesian optimization and population-based methods. In dedicated steering campaigns, gaussian process and forest-based Bayesian minimization rapidly improved transmission, while more advanced multi-objective optimization allowed the team to improve beam current and pulse flatness simultaneously.

In the coming months, the RF amplifier will be connected directly to the cavity and the bunched beam will be characterized with the FFC installed at the end of the line.

Figure 1: MHB experiment last configuration assembly process. From left to right: ACCT, MHB, ACCT, WF, FFC

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`https://isolde.web.cern.ch`

[1] This work was funded by Spanish MCIN, Recovery and Resilience Funds, and European Union "NextGenerationEU".

Progress in Developing the ISOLDE Superconducting Recoil Separator (ISRS)

Results of LoI INTC-I-228

I. Martel, F. Torabi, I. Bustinduy, T. Kurtukian-Nieto, J. Resta for the ISRS collaboration

[1] The ISOLDE Superconducting Recoil Separator (ISRS) [1] is a compact superconducting spectrometer under development at HIE-ISOLDE for radioactive-beam studies. Using nested multifunction superconducting canted-cosine-theta (CCT) magnets, it separates and identifies reaction products by mass-to-charge ratio, time-of-flight, energy, and charge.

Realistic nuclear-reaction calculations have been incorporated into the separator design. Multi-code studies across a wide range of systems have provided cross sections and angle–energy distributions for Monte Carlo simulations and beam-dynamics studies, linking reaction physics directly to optics design.

The ISRS lattice has converged to ten straight combined-function CCT magnets with 580 mm effective magnetic length and a 36° bending angle. Isochronous and quasi-isochronous optics have been studied [2]; Fig. 1(a) shows the simulated time–energy distribution of Ra species after ten revolutions in quasi-isochronous mode, with about 8 ns separation; complementary studies indicate about 11 ns in isochronous mode. Beam-dynamics studies, including fifth-order transfer matrices, show limited higher-order effects owing to system symmetry. Recent updates have refined injection and extraction through a superconducting septum, a fast RF kicker, and enlarged apertures.

A Magnetic Field Scanning System (MFSS) has been developed for MAGDEM (MAGnet DEMonstrator) [3], the prototype multifunction CCT magnet of the ISRS ring. Using multi-axis positioning and a HallinSight® 32×2 sensor array, it achieves 4 μT resolution and 0.2% calibration accuracy, with first measurements in very good agreement with simulations.

The multi-harmonic buncher (MHB) provides the longer bunch spacing required for ISRS while remaining synchronized with the HIE-ISOLDE linac. At 10.128 MHz, it was commissioned with 10.094 keV H_2^+ beams at $\beta = 0.00328$; RF-Track agreement was good, and Bayesian and multi-objective optimization improved transmission and pulse flatness.

These developments come together in the Ion Test Bench (IONTB) [4], an ISRS prototype platform combining MAGDEM, the MHB, and the focal-plane detector for staged validation (see Fig. 1(b)). Linear-spectrometer optics were optimized using reused CERN quadrupoles at CMAM. Overall, progress in reaction modelling, beam dynamics, magnetic-field mapping, buncher development, and detector R&D based on SiC, Si, and gamma systems shows that the project has advanced well beyond the conceptual-design stage toward a credible recoil-analysis capability at ISOLDE.

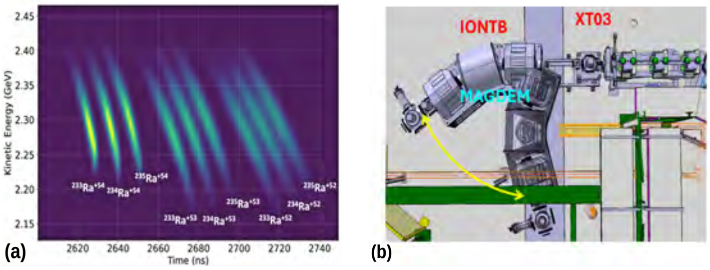

Figure 1: (a) Time–energy distribution of Ra species after ten revolutions in quasi-isochronous mode. (b) IONTB layout with MAGDEM at XT03, CERN.

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`https://www.uhu.es/isrs/`

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The HIE-ISOLDE Timing Array for Reaction Studies: HISTARS

N. Bernier, M. Caballero, V. M. Nouvilas, L. M. Fraile et al.
for the HISTARS collaboration

The HIE-ISOLDE facility provides unique opportunities for nuclear-structure studies with post-accelerated beams, particularly through transfer reactions and Coulomb excitation. To fully exploit these possibilities, there is a need for detector systems capable of measuring excited-state lifetimes in-beam with high sensitivity and good selectivity. In this context, the HISTARS array is being developed as a dedicated instrument for lifetime measurements of nuclear states populated in reactions[1]. The main goal is to combine fast timing capabilities with existing spectroscopic infrastructure to measure lifetimes simultaneously with reaction observables and enable new measurements of electromagnetic transition strengths, quadrupole collectivity, and shape coexistence.

The HISTARS concept is based on a hybrid approach that combines an inner charged-particle detector system, optimized for reaction tagging and fast timing, with an external fast γ-ray array based on $LaBr_3$(Ce) scintillators. Such a configuration is designed to permit lifetime measurements through particle-γ and γ-γ coincidences, while also retaining the spectroscopic advantages of coupling to high-resolution HPGe detectors such as Miniball clusters [1]. The array design benefits from recent advances in scintillator technology [2, 3], digital electronics, and signal-processing methods [4], with the aim of reaching the sensitivity required for lifetimes in the tens-of-picoseconds to nanosecond range.

A central part of the development is the optimization of the detector geometry through Geant4 simulations. Figure 1 shows the two main array configurations under study. In the *central* geometry, 36 $LaBr_3$(Ce) detectors are arranged around 90°, together with 8 Miniball clusters. In the *backward* geometry, 24 $LaBr_3$(Ce) detectors are placed around $\sim$ 140°, together with 6 Miniball clusters. These configurations are being evaluated in terms of efficiency, Doppler-shift reduction, and mechanical compatibility with the existing setup.

The HISTARS fast-timing array is currently in the design and procurement phase. Test of scintillator crystals, including GaGG(Ce) and YSO(Ce), and plastic scintillators coupled to fast SiPMs have been performed with stable beams. Several fast photomultiplier assemblies matched to $LaBr_3$(Ce) crystals are also being characterized [5].

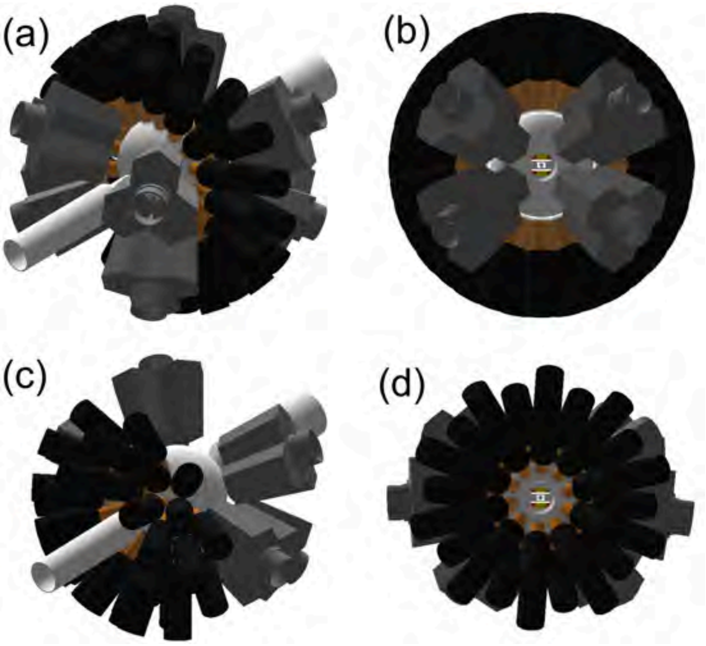

Figure 1: Proposed geometries for the HISTARS and Miniball arrays: **(a-b)** central and **(c-d)** backward geometries.

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[1] This work was funded by Spanish MCIN, Recovery and Resilience Funds, and European Union "NextGenerationEU".

Neutron and α-transfer in ^{7}Be + ^{12}C reaction at 5 MeV/u

Results of experiment IS554

Niloy Ghosh and Dhruba Gupta for the IS554 collaboration

The 1*n* and α-transfer reactions have been widely studied for weakly bound stable nuclei [1, 2]. Similar studies with radioactive beams are however limited [1, 3]. Existing work on the ^{9}Be + ^{12}C reaction at 2.2 MeV/u [4] revealed that neutron transfer dominates at forward angles, while α-transfer becomes more important at backward angles. The 1*n* transfer reaction in ^{7}Li + ^{13}C has been studied earlier at about 5 MeV/u [5]. The results indicate that coupled channel effects are an attribute to ^{7}Li induced single nucleon stripping reaction on light targets in this energy region. In the present work, we report the study of the ^{12}C(^{7}Be,^{8}Be*)^{11}C* reaction for the first time. This reaction can proceed through both 1*n* and α transfer. The experiment used a 5 MeV/u ^{7}Be beam on a CD$_2$ target at the Scattering Experiment Chamber (SEC) of HIE-ISOLDE [6, 7]. The beam intensity was $\sim 10^5$ pps and the pentagon array detected the charged particles from the reaction. Events with two coincident α-particles recorded in the pentagon array were considered. The energy correlation between these two particles confirmed that they originate from the breakup of the intermediate ^{8}Be nucleus. The ^{8}Be can be populated by two reactions, namely ^{12}C(^{7}Be,^{8}Be*)^{11}C* and *d*(^{7}Be,^{8}Be*)*p*. To separate these reactions, we generated the Catania plots [8], which are kinematic techniques employed when one of the outgoing particles remains undetected. After separating the transfer channels leading to ^{11}C, the *Q*-value was reconstructed event by event. Fig 1 displays the *Q*-value spectrum, showing a peak at 0.27 MeV corresponding to the ground state of ^{11}C. The other peaks in the figure correspond to the excited states of ^{11}C at 2.00, 4.31 and 4.80 MeV respectively. Theoretical calculations are underway to interpret the relative contributions of the single-nucleon and cluster transfer probabilities.

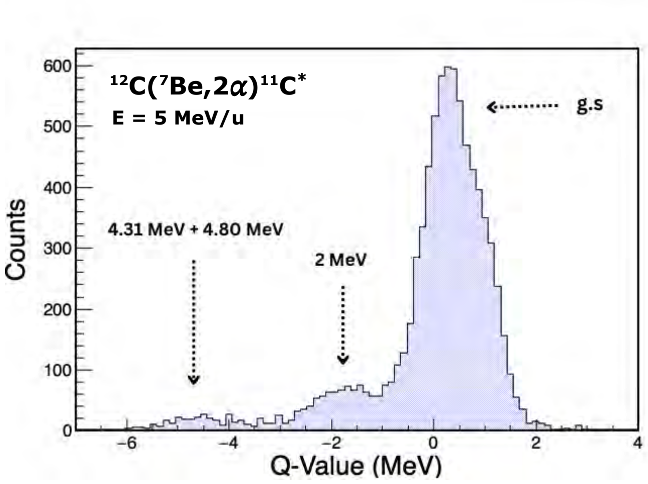

Figure 1: The *Q*-Value spectrum of the ^{12}C(^{7}Be,2α)^{11}C* reaction at 5 MeV/u.

The IS554 collaboration thank the ISOLDE engineers in charge, RILIS team and Target group at CERN for their support. D. Gupta acknowledges financial support from ENSAR2 (Grant no. 654002) and ISRO, Govt. of India (Grant no. ISRO/RES/2/378/15–16). N. Ghosh acknowledges the support of the CSIR-NET fellowship (File No. 09/0015(17827)/2024–EMR–I).

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Implementation of the recoil distance Doppler-shift technique at ISOLDE

Results of experiment IS656

Christoph Fransen for the IS656 collaboration

Absolute transition strengths between excited states yield fundamental information on nuclear structure and can be determined from level lifetimes. The recoil distance Doppler-shift (RDDS) technique is valuable to measure lifetimes in the picosecond range [1] from quantities that are directly accessible in an in-beam experiment. Here, the RDDS technique was used for the first time at ISOLDE to prove its high capability to investigate exotic nuclei employing a sophisticated plunger device developed at the Institute for Nuclear Physics, University of Cologne.

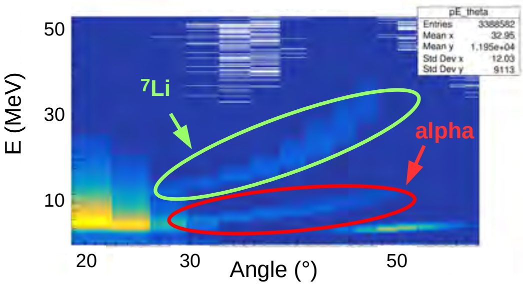

Figure 1: Scattering angle in relation to the energy loss of ejectiles emitted after the incomplete fusion reaction in this experiment.

Excited states in ^{144}Ba were populated with an incomplete fusion reaction: a ^{144}Cs beam from HIE-ISOLDE with of 4.7 MeV/u and $\approx 10^6$ pps was applied to a ^{7}Li target with a thickness of 1.3 mg/cm^2 evaporated on a 0.93 mg/cm^2 ^{nat}Ni foil facing the beam. After the breakup of ^{7}Li into a triton and an α particle the fusion with the triton lead to the compound nucleus ^{147}Ba where ^{144}Ba was produced after the emission of three neutrons. The ^{144}Ba reaction products left the target foil with a recoil velocity of 8%c and were degraded to 4.4%c in a 11.5 mg/cm^2 Ta foil to achieve a sufficient separation of the Doppler-shifted γ rays emitted before and after the degrader, respectively. γ-rays were detected with the MINIBALL Germanium cluster detectors at forward and backward angles of 45° and 135°. The reaction channel to ^{144}Ba was separated by detecting the emitted α particle (see Fig. 1) with an annular DSSSD detector mounted directly downstream from the plunger degrader.

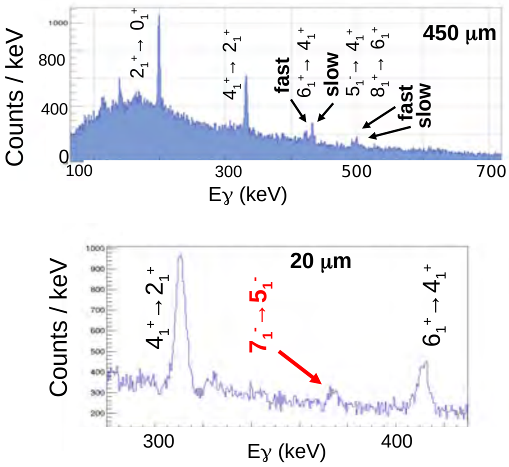

Figure 2: γ-ray spectra of ^{144}Ba created with a gate on α particles. Top: spectrum of all MINIBALL Germanium detectors at backward angle of 135°, Doppler corrected for recoil velocity after the degrader, for a distance of 450 μm. Below: $7_1^- \rightarrow 5_1^-$ transition using the same Doppler correction but for the smallest distance of 20 μm.

The gate on α-particle events yields very clean γ-ray spectra of ^{144}Ba (see Fig. 2). Doppler-shifted γ-ray transitions in ^{144}Ba can be clearly observed so that lifetimes of the related states can be determined. Besides transitions within the yrast band of ^{144}Ba also the $7_1^- \rightarrow 5_1^-$ transition was observed allowing the determination of the lifetime of the 7_1^- state.

The data are analyzed within a PhD thesis. This work was supported by the German BMFTR, Joint Project 05P2024 - ISOLDE, Grant No. 05P24PK2.

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RIB Applications

Investigating the origins of the kink in the charge radii at N = 28 with β-NMR

Results of experiment IS765

Magdalena Kowalska for the VITO collaboration

Recent nuclear-structure studies of the VITO team concern the origins for the kink in the charge radii of potassium and calcium isotopes across N=28 [1]. Our aim is to address whether the kink is due to deformation or increased size by looking into the distribution of the nuclear magnetisation, which should provide an alternative view compared to charge radii [2, 3].

The finite magnetisation of a nucleus leads to a small correction to the hyperfine-splitting (HFS) constant, known as the Bohr-Weisskopf (BW) effect. Experimentally, it is easier to obtain a differential BW effect between two isotopes from the ratio of their g-factors and HFS constants. As this effect is usually below the 1% level in lighter nuclei, we determine g-factors with ppm accuracy using liquid-state β-NMR. For the HFS constants, we plan to reach 10^{-4} relative precision with the laser-rf double resonance technique we are presently developing.

Last year we employed liquid-state β-NMR to improve the precision of the g-factors of ^{47,48,49}K. For this study, we used our recently commissioned energy-resolving β detectors [4]. These detectors proved crucial for ^{49}K, where several of the strongest transitions have opposite signs of the β-decay asymmetry. By selecting the highest-energy events populating only the lowest state, we substantially improved the signal-to-noise ratio, making the g-factor improvement possible, as seen on the reference resonances in KCl in Fig. 1.

The β-NMR resonances collected for ^{47,48,49}K are now being analysed by two PhD students. If the obtained differential BW effects are large, the precision of the HFS constants from laser spectroscopy at COLLAPS [5] may be sufficient for interpretation. However, if the effects are small, interpretation will require our precise measurements with the laser-rf spectroscopy line.

We have recently determined precisely the differential BW effect ^{39,47}K and provided the first microscopic description of their magnetisation distribution [6]. DFT was used to obtain radial moments of the magnetisation distribution. These moments were combined them with state-of-the art atomic calculations. The comparison between experiment and theory allowed us to investigate the composition and distribution of magnetisation in these nuclei. We will now employ this approach to address the kink in charge radii at N = 28.

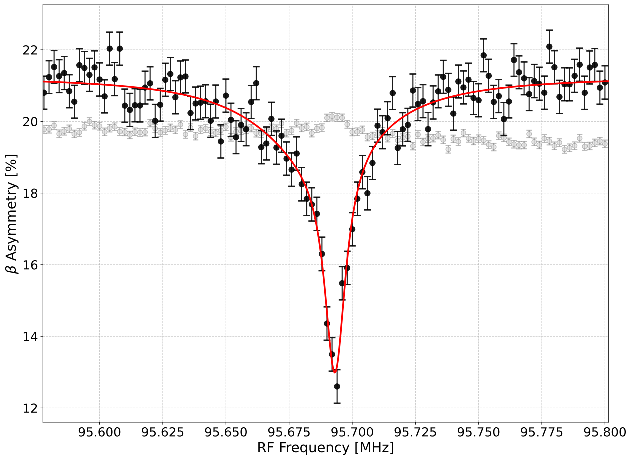

Figure 1: β-NMR resonance of ^{49}K in KCl crystal without (grey) and with (black) selection of highest-energy events.

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Compact setup for Dynamic Nuclear polarisation on stable and unstable nuclei

Michael Pesek for the VITO collaboration

Nuclear Magnetic Resonance (NMR) [1] is a powerful technique with a variety of applications in research and medical imaging. The NMR signal is directly proportional to nuclear polarisation, which is low at room temperature and high magnetic fields currently available commercially. One way of addressing this challenge of low sensitivity is to use hyper-polarisation to enhance the nuclear polarisation beyond thermal equilibrium. Such techniques include e.g. optical pumping (used very successfully at VITO), para-hydrogen based chemical methods and Dynamic Nuclear Polarisation (DNP) [2]. The DNP has reached the highest polarisations, over 90 % for protons in certain chemical compounds [2]. It makes use of the fact that electron magnetic moments is 1800x larger than that of the nucleus. This means that at low temperatures <4K and intermediate magnetic fields of 2.5T the electrons are almost completely polarised. Applying microwave radiation at a frequency close to the electron Larmor frequency then allows for the transfer of the high electron polarisation to the nuclear system.

DNP has been successfully used to provide highly polarised proton and deuteron targets for high energy scattering experiment at CERN and elsewhere. However, the adoption in the NMR community has been quite slow partly due to the high complexity and cost of such a system.

In 2024 the CERN Medical Applications funding allowed us to start the development of a compact and relatively cheap DNP system that could be fitted in a standard commercial liquid He dewar thus reducing the cost and opening DNP to a wider community. The aim is for > 1 % polarisation of stable and unstable nuclei at 1.5 K and 2.5 T.

The magnet, Fig.1, constructed in CERN's EP-DT workshop was successfully tested in December 2025 in CERN's Cryolab. The next steps involve NMR tests without hyper-polarisation and the first DNP test on a stable isotope. In addition to enhancing the polarisation of stable nuclei, the polarisation of long lived radioactive isotopes is also planned. This would allow for the use of radiation-detected NMR outside of the VITO beam-line at ISOLDE. The first candidate is β+ emitter ^{18}F (half-life of 110 min) which is available as a PET agent and has high decay asymmetry parameter. To perform this experiment further developments are needed, including set of scintillating beta detectors that will operate inside the limited space and work at 1.5 K.

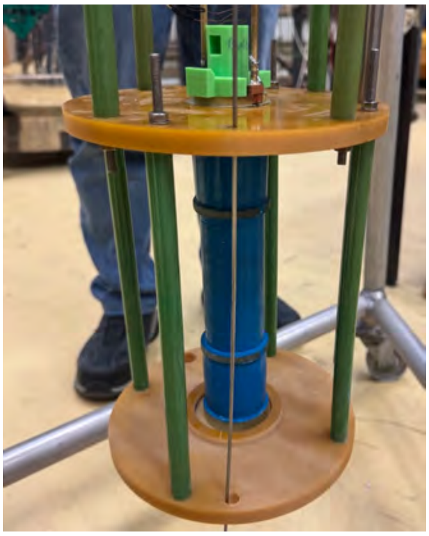

Figure 1: 2.5 T SC magnet ready for tests in CERN's Cryolab

We gratefully acknowledge the CERN Medical applications fund and the help of A. Dudarev, EP-DT workshop and Cryolab team.

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Probing ion mobility over buried interfaces in solid-state battery materials

Results of experiment IS764

Amy Sparks for the VITO collaboration

The β-NMR technique employed at VITO offers exceptional sensitivity together with high spatial and temporal resolution, enabling detailed studies of interfacial ion mobility[1]. Its low implantation energy provides non-destructive access to buried interfaces that are notoriously difficult to probe using conventional methods, which often require surface modification or damage[2].

This capability is particularly important for solid-state battery (SSB) optimisation, where characterisation of buried interfaces between anode, electrolyte, and cathode layers is essential. In 2025, β-NMR measurements at VITO investigated the interface between a Li anode and the argyrodite electrolyte Li_6PS_5Cl, a commercially relevant SSB material that forms a self-passivating solid-electrolyte interphase (SEI) predicted to suppress diffusion and degrade charge–discharge performance[3].

Expanding VITO to these applications required reconstruction of the end station (Fig. 1), funded by CERN's Knowledge Transfer group. New capabilities included ultra-high vacuum operation, controlled sample heating and cooling, load-lock insertion of air-sensitive samples, upgraded RF coils, remote manipulation, and a cryogenic trap. Synergy with VITO's magnetisation distribution project further enabled energy-resolving β-detectors and a collimator.

^8Li ($t_{1/2}$ = 838 ms) was implanted at 30 keV through the anode, with spatial resolution controlled via PVD-deposited lithium thickness. Temperature-dependent spin depolarisation rates (T_1) for ions in the SEI and electrolyte revealed higher resistivity in the SEI, as illustrated by preliminary room-temperature data (Fig. 2). This study represents the first β-NMR materials science application at VITO and the first polarisation of ^8Li at the beamline, opening new opportunities for battery and functional-materials research. This work is in collaboration with CERN's KT group, University of Oxford, the Faraday Institution, and the Paul Scherrer Institute; we gratefully acknowledge their support and funding.

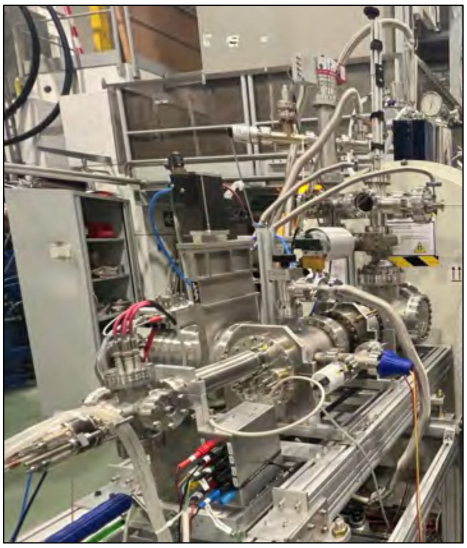

Figure 1: The new VITO end station at ISOLDE.

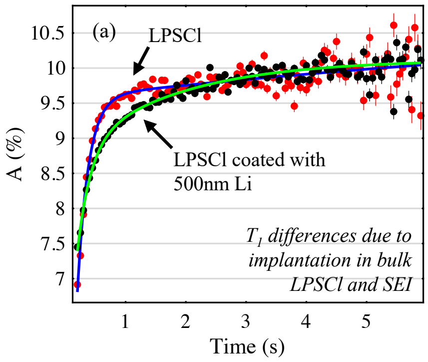

Figure 2: β-NMR signals at VITO for bulk and layered samples, showing differences in spin depolarisation with time.

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Quenching of the radiative-decay fraction of $^{229\mathrm{m}}$Th implanted in different large-bandgap crystals

Results of experiment IS715

Y. Elskens for the IS658 and the IS715 collaborations

Due to its low excitation energy of around 8.4 eV, the unique ^{229}Th isomer is an ideal candidate for the development of a nuclear clock, particularly suited for studies in fundamental physics [1]. Following the approach of [2], the radiative decay of the isomer was measured with a vacuum-ultraviolet (VUV) spectrometer by populating the isomer through the β decay of ^{229}Ac [3]. This was achieved at ISOLDE by implanting radioactive ^{229}Ra/^{229}Ac beams into CaF_2 and MgF_2 crystals, significantly reducing the uncertainty on the transition energy and paving the way for laser excitation of the isomer in CaF_2 [4] and $LiSrAlF_6$ [5]. Subsequently, laser excitation in CaF_2 using a VUV frequency comb further reduced the relative uncertainty on the transition energy to the 10^{-12} level [6].

Following the initial success of the original VUV-spectroscopy experiment, two further experimental campaigns were carried out at ISOLDE (in 2023 and 2025), focusing on the role of the chemical environment. The use of large-bandgap crystals in the development of a nuclear clock enables suppression of the otherwise dominant internal-conversion (IC) decay channel if the thorium atoms are introduced in the crystal such that the energy gap between the highest occupied and lowest unoccupied electronic states exceeds the isomeric transition energy. As the host's crystalline structure determines for which sites this is the case, the suppression of IC decay is dependent on the crystal material. During the IS715 campaigns, the radiative decay of the isomer was observed in $LiSrAlF_6$ [7], $LiCaAlF_6$, SrF_2, $BaMgF_2$, and BaF_2, effectively identifying these crystals as possible host materials for a nuclear clock.

We further investigated the influence of the chemical environment by studying the time behaviour of the radiative-decay signal in different large-bandgap crystals. This revealed a crystal-dependent quenching mechanism induced by the β decay of the precursor nuclei (see Fig. 1). In addition, by implanting a ^{220}Fr decay chain on top of the ^{229}Ra decay chain, further quenching induced by α decay was observed. A clear temperature dependence was also observed, with enhanced quenching observed at higher temperatures.

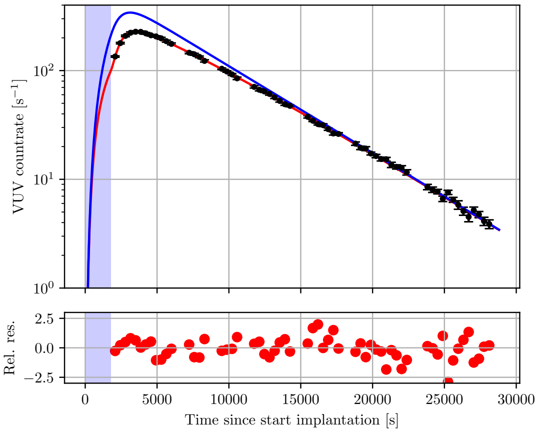

Figure 1: Time behaviour of the radiative decay of $^{229\mathrm{m}}$Th in CaF_2. The data cannot be described by a standard Bateman equation (blue), but have to be modeled by taking an activity-dependent quenching mechanism into account (red).

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Radiotracer photoluminescence experiments from PbV color centers in diamond

Results of experiment IS668

Ulrich Wahl for the EC-SLI collaboration

Among the group-IV vacancy centers in diamond, the negatively charged PbV^- is emerging for possible applications in quantum network nodes, where it may allow device operating temperatures up to 10 K [1]. The neutral PbV^0 has been predicted to exhibit also long spin-coherence times [2, 3], raising the possibility for operating temperatures still exceeding those of PbV^-. Current research efforts focusing on manipulation and transformation of the PbV charge state [4, 5] indicate that it may be feasible to transform PbV^- to PbV^0 and vice-versa using 445 nm blue and 532 nm green laser light, respectively. However, so far it has not been possible to directly observe photoluminescence (PL) from PbV^0. Since diamonds are often found to exhibit a variety of PL lines following implantation of Pb [6], it is of particular relevance to identify which ones are actually due to the chemical nature of the implanted impurity rather than radiation damage or other impurities.

In our latest Pb beam time before LS3 (10/2025) we investigated the radiotracer PL (rPL) from radioactive ^{209}Pb ($t_{1/2}$=3.25 h) in single-crystalline CVD diamond ("electronic grade" with [N]<5 ppb) following 30-keV low-fluence (5×10^{12} cm^{-2}) RT implantation and annealing at 1150℃. The results (Fig. 1) showed two major zero-phonon lines (ZPL) at 552 nm and 575 nm as well as a number of minor lines, all of which were found to decrease with an observed half life of 3.5 h, i.e., very similar to the radioactive half life of ^{209}Pb. While the first line at 552 nm is well-known to result from the PbV^- ZPL [1, 4, 5, 6], the second one at 575 nm had previously been suspected to be a possible contamination of nitrogen-vacancy centers NV^0 [6], which also exhibit their ZPL at 575 nm. Our results clearly establish the 575 nm line in our sample as being Pb-related, however, its exact nature remains unknown at present. A possible candidate may be PbV^0, which has its ZPL theoretically predicted at 561 nm [2] or 571 nm [3]. Additional optical characterization, which is to be performed by low-temperature PL on samples implanted with stable ^{208}Pb at ISOLDE under identical conditions as the radioactive ^{209}Pb, is expected to shed further light on the nature of the newly discovered Pb-related 575 nm ZPL.

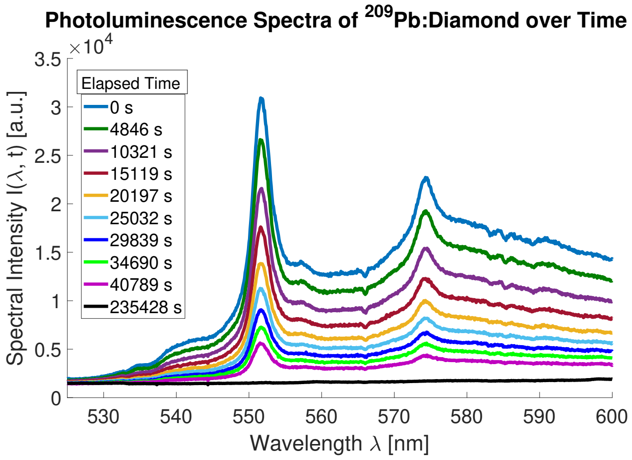

Figure 1: rPL spectra from radioactive ^{209}Pb at various time intervals after sample preparation, using 457 nm blue laser excitation. Both the major ZPLs at 552 nm and 575 nm, as well as a number of minor lines (at 541 nm and 558 nm) and their phonon sidebands disappear according to the radioactive half life of ^{209}Pb.

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`https://isolde.web.cern.ch/ec-sli`

Toward EDM-sensitive color centres: multi-vacancy actinide defects identified in diamond

Results of experiment I-281

Kirill Danilov for the EC-SLI collaboration

The development of solid-state platforms for precision tests of fundamental symmetries has recently gained significant momentum. In particular, diamond color centres incorporating heavy nuclei with octupole deformation have been proposed as a promising route towards highly sensitive electric dipole moment (EDM) measurements [1], exploiting the large nuclear Schiff moments expected for isotopes such as ^{229}Pa, ^{227}Ac and ^{229}Th. A key open question in this approach is whether the specific defect configurations predicted to host such nuclei, namely non-centrosymmetric multi-vacancy complexes, can be created in diamond. Recent density functional theory calculations suggested that the double-vacancy configuration (PaV_2) is both energetically favourable and particularly suitable for EDM experiments due to its broken inversion symmetry and resulting internal electric fields [1].

At ISOLDE, we have taken a decisive step towards answering this question. Using emission channeling, we investigated the lattice location of implanted actinide ions in diamond, with ^{231}Pa, ^{231}Th and ^{229}Ac as probe isotopes. A range of defect configurations are formed (Fig. 1) beyond the commonly observed substitutional and bond-centred sites (with zero and one vacancy, respectively). In particular, a significant fraction of the implanted ions occupy lattice sites consistent with double-vacancy defects (e.g. AcV_2), predicted to be optimal for EDM sensitivity [1]. These findings represent the first direct experimental evidence for the formation of higher-order vacancy complexes involving impurities in diamond. The observation that such configurations can be created under implantation and annealing conditions accessible at ISOLDE is a crucial milestone, strongly supporting the feasibility of engineering actinide-based quantum emitters tailored for fundamental symmetry tests.

As a next step, we will perform photoluminescence experiments on diamond implanted with ^{229}Th and ^{231}Pa, with the aim of identifying optical transitions associated with these defects and assessing their suitability for future EDM experiments.

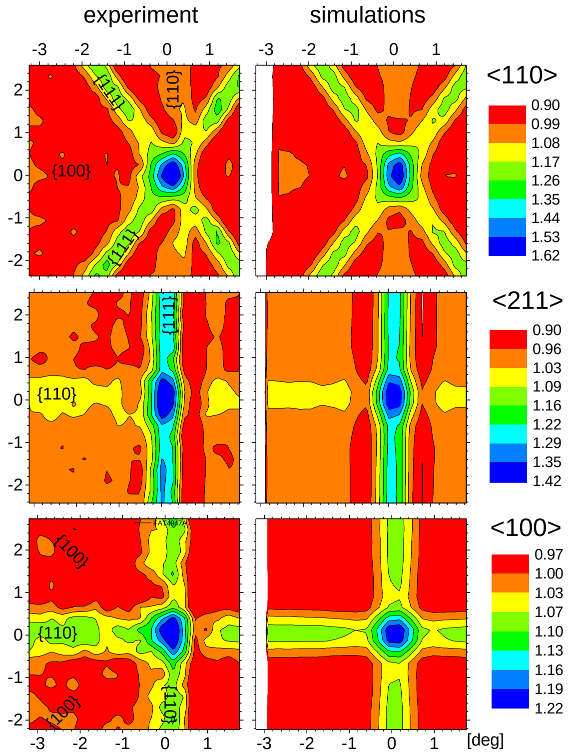

Figure 1: (*Left*) Normalized experimental β^- emission channeling patterns of ^{229}Ac in diamond, in the vicinity of $\langle 110 \rangle$, $\langle 211 \rangle$, and $\langle 100 \rangle$ axes. (*Right*) Best fits with simulated patterns corresponding to a combination of sites (defect configurations): substitutional (11%), AcV (23%), AcV_2 (33%) and AcV_3 (33%).

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`https://isolde.web.cern.ch/ec-sli`

MULTIPAC and PACBit – Third Generation of TDPAC Spectroscopy

Results of project LOI249

Björn Dörschel, Ian Chang Jie Yap, Juliana Heiniger-Schell, Doru Constantin Lupascu for the Solid State Physics collaboration

1 TDPAC Background

Time-Differential Perturbed Angular Correlation (TDPAC) spectroscopy utilizes an implanted isotope with γ-γ decay to study the hyperfine interaction in materials. Via a coincidence search, the two γ rays that are emitted by the same nucleus are identified. With the coincidence, it is possible to determine the perturbation function $R(t)$. The perturbations themselves arise from internal magnetic and electric fields in the material and affect the γ ray emission distribution. More precisely, they change the spin of the intermediate state of the nucleus (see Fig. 1). After emitting the first γ ray, the nucleus goes into the intermediate state I_m, where the spin of the state is perturbed by the internal fields. According to the lifetime, the second γ ray is emitted, which carries the information of this perturbation. By detecting both γ rays for many nuclei of identical local environment in a crystal, it is possible to determine this perturbation and thus the internal fields, local structure, and dynamic properties on unit-cell level [1].

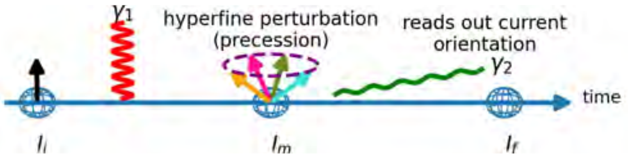

Figure 1: Illustration of TDPAC spectroscopy.

2 MULTIPAC

MULTIPAC is an exclusive setup that will allow TDPAC spectroscopy under external magnetic fields up to 8.5 T and at temperatures between 3 K and 375 K. It consists of six $LaBr_3(Ce)$ detectors with Si-Photomultipliers and U5310A digitizers. This provides 10-bit resolution and a 0.1 ns sampling interval. MULTIPAC will be moved to ISOLDE in April 2026. Following testing and calibration, it will be fully functional during the long shutdown 3 and available for the LOI249 collaboration [2].

3 PACBit

PACBit is a software package for MULTIPAC and other TDPAC setups. To utilize the digitizer sampling rate as well as the low dead time, a high-throughput data acquisition algorithm with parallel programming and MPI shared windows is being developed. The post-processing and the coincidence search are parallelized to enable real-time $R(t)$ plotting during spectroscopy. Currently, fitting a single $R(t)$ curve can take multiple days. For this reason, a machine-learning program will be trained to fit the $R(t)$ function in real-time. The steps up to plotting the $R(t)$ function are already implemented and fully tested. The fitting will be developed during long shutdown 3 alongside a graphical user interface.

Acknowledgements

We acknowledge BMFTR for support provided through the grants ISOLLINK 05K25PGA and PACBit 05K22PGB.

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`https://ssp.web.cern.ch`

Other News

MEDICIS and MELISSA operation and highlights in 2025

Cyril BERNERD, Matthieu DESCHAMPS, Charlotte DUCHEMIN, Katerina CHRYSALIDIS, Manikanta ELLE, Patricija KALNINA, Laura LAMBERT, Edgars MAMIS, Ralitsa MANCHEVA, Ralf Erik ROSSEL, Arfan TARIQ, Joachim VOLLAIRE, Thierry STORA
on behalf of the CERN-MEDICIS collaboration

4 Highlights from operation in 2025 and insights for 2026

In 2025 CERN-MEDICIS operated for the seventh consecutive year. MEDICIS was approved for operation until 2030, with an enlarged scope beyond providing mass separated novel radionuclides to MEDICIS collaboration members and to users of the PRISMAP European medical isotope programme. Supply to an industrial pharma leader and approval of the clinical use of MEDICIS isotopes by the Council were new directions for MEDICIS. With the last protons at ISOLDE before Long Shutdown 3 (LS3) and ISOLDE beam dump replacement, MEDICIS was also pushing the boundaries of its operations and the achieved results.

In 2025 MEDICIS operated with 11 newly produced ISOL target and ion source units, and with 8 units reused from previous years. This included a target unit that has been irradiated 10 times and used in 6 isotope collections, as well as a target unit for external sample mass separations used 11 times. Both are still in operational condition, showcasing the quality of target unit production and their operation in collections as well as efficient use of the facility resources. In close collaboration with the ISOLDE team, MEDICIS utilized 5.19E+19 CERN PSB delivered protons for the production of isotopes with 2.42E+19 used in direct mode, by deflecting the proton beam below the ISOLDE target. As it was in 2024, the highest demand was observed for the radionuclides produced in proton-irradiated ThC_x and ThO_2, such as Ra-223, Ra-224 and Ra/Ac-225. Tb-149, Tb-155, Eu-145 and Tm-165 radionuclide were also provided and mass separated from different types of tantalum targets. Machine developments also resulted in the first successful laser-ionized Cu-67 and Ac-226 collections at MEDICIS from UC_x and ThO_2 target materials, respectively. External sample mass separations in 2025 included Yb-175 and Sm-153, with record activities of up to 1.5 GBq collected on a single foil per batch at the end of collection. This highlights the technological readiness of the MEDICIS facility to provide mass separated isotopes for clinical setting applications. In total a record activity of 4.57 GBq was collected and delivered for the biomedical program in 2025. A total of 20 shipments to the users followed within Europe and as far as to the USA [1].

At the end of 2025, the first Sc-47 sample was shipped to the University of Latvia (LV) for radiochemical separation and labeling studies, achieving a milestone both for the MEDICIS collaboration and molecular beams production, transiting into routine production operations [2]. When the half-life and activity of isotopes collected did not allow for shipment, the MEDICIS collaborating partners from Riga Technical University (LV), National Physics Laboratory (UK) and Hôpitaux Universitaires Genève (CH) carried out their experiments in MEDICIS Class A labs, to work with K-43, Tb-149, Ra/Ac-225 and Ac-226 radionuclides. This type of operation had also been used for measurements at the ISOLDE Decay station, and is set to continue with in-

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https://medicis.cern

creased capacity in 2026.

A campaign of radionuclide release studies from various target materials was continued in 2025, marking the 3rd consecutive year of gaining data and experience to support the understanding of the isotope release of irradiated target materials used for radioactive ion beam production both at MEDICIS and ISOLDE. Micrometric TaC target materials were studied for high temperature exposure and isotope release properties up to 2500 °C [3].

The collaboration between MEDICIS, ISOLDE and SCK-CEN (BE) was also strengthened by welcoming colleagues from SCK-CEN for their first ThO_2 ISOL target material prototype testing in the context of the upcoming ISOL@MYRRHA facility. The release and production of Cs-128/129, Ra-224/225/226 and Ac-225/226 ion beams was studied. Another collaboration with the University of Latvia includes TiC-MWCNT and TaC-MWCNT target material developments for enhanced material resistance to high temperature sintering and improved Sc and Tb molecular beam production. Such nanomaterial prototype targets were operated under proton irradiation and isotope separation at MEDICIS, yielding promising results for future operation.

5 MELISSA laser laboratory update

In 2025, the MELISSA laser laboratory was used for the collection of radionuclides from Ac, Yb, Tm, Sm and Eu. Also, first results were obtained for Cu and Ra laser ionization. The later was possible thanks to the use of a Raman laser, for which new crystals were obtained after waiting for more than a year in production. In parallel, optical pumping at the same wavelength as the Raman laser was achieved using a new bi-refringent filter in the Ti:Sa cavity, allowing an easy extension of the initial wavelength coverage, reaching 482.72 nm, the required wavelength of the first step for radium ionization.

A new project called TALISMAN (Turnkey Automated Laser Ionization System for Medical Application of Radioisotopes) was funded by CERN's Knowledge-Transfer (KT). The project aims at automating key aspects of the MELISSA laser laboratory in order to make it operator-free in the future. For that purpose, a study of new control hardware and implementation of Machine Learning, in collaboration with BE-CSS-DSB, will be conducted. The project started on the 1st of January 2026.

Finally, first tests to generate wavelengths covered by the dye lasers (not implemented at MEDICIS) was conducted by the RILIS team. Promising results were obtained, showing the possibility to extend the capabilities of RILIS-type laser laboratories with full solid-state laser solutions based on nonlinear optics. This perspective opens the possibilities that can be explored in MELISSA for laser ionization in the future.

6 Developments of Tb isotope mass separation

For nuclear medicine applications, ^{155}Tb can be produced via high-energy proton-induced spallation of tantalum foils. This process is typically combined with either online or offline mass separation to achieve high isotopic purity. However, the final product can be affected by isobaric contamination from $^{139}Ce^{16}O$ ions. Similarly, ^{149}Tb obtained through mass separation may be contaminated by $^{133}Ce^{16}O$.

To improve terbium mass separation, new target materials were investigated in 2025, including tantalum carbide (TaC_x) and, for the first time at the CERN-MEDICIS facility, a nanostructured material: TaC combined with multi-walled carbon nanotubes (TaC-MWCNT). Terbium was succesfully collected in the molecular form as terbium di-fluoride from TaC-based materials, achieving a mass separation efficiency of approximately 2%, with no cerium contamination detected in any of the collections. However, a second campaign using a previously used TaC target showed a nearly tenfold decrease in collection efficiency, likely due to material sintering. Consequently, a dedicated campaign studying the sintering behavior of tantalum-based target materials was completed [4].

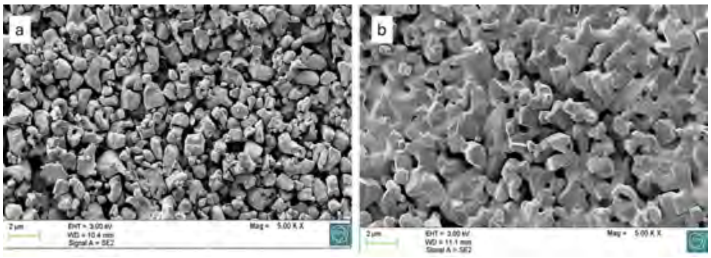

Figure 1: TaC a) as purchased b) heated to 2000 °C

To mitigate the sintering effects observed with pure sintered TaC, the nanostructured TaC-MWCNT material was introduced and tested at MEDICIS twice by the end of 2025. The key observation was that, on the second use of the same target, the decrease in mass separation efficiency was improved by an order of magnitude, indicating the potential of TaC-MWCNT for future Tb molecular ion beam production and transition into routine operations.

7 What's next for MEDICIS

MEDICIS will restart in 2026 and operate during LS3 with only external partner institute sources, similarly to what has been successfully demonstrated during LS2. Some batches will be made available for ISOLDE experiments.

The PRISMAP programme came to completion at the end of 2025. Over the past few years, PRISMAP selected 47 user projects and delivered an impressive 159 radionuclide batches. CERN-MEDICIS continued to play a pivotal role in delivering radionuclides by mass separation, while hosting some institutes to progress in standardization approaches. With a small number of studies reaching the clinical stage, the programme was identified for prolongation by the European Commission, and a new phase has been approved, PRISMAP+ furthering the European medical radionuclides programme. It is being implemented and expected to take over in summer this year. As with PRISMAP, innovative radionuclides will be provided to cover a wide range of biomedical research.[5]

8 Acknowledgments

We wish to thank all our colleagues from SY-STI, BE-CEM, BE-OP, HSE-RP, EP-SME and the institutes that are part of the collaboration for their support.

References

[1] E. Mamis, *et al.*, ISOLDE Workshop and Users meeting 2025; https://indi.to/jcPZq.

[2] R. J. Zabolockis, E. Mamis, L. D. Pakalniete, *et al.*, *Submitted for publication in EJNMMI Radiopharmacy and Chemistry* .

[3] P. Kalnina, E. Mamis, C. Duchemin, *et al.*, *Submitted for publication in Nuclear Inst. and Methods in Physics Research, B* .

[4] P. Kalnina, *et al.*, Prepared to be published in 2026.

[5] https://medical-radionuclides.eu;
https://prismap.eu.

ISOLDE support

Access and contacts

1. Use the online EDH Pre-Registration tool[1] which should be launched by your team leader or deputy team leader. You need to attach the following documents to the pre-registration:
    - Home Institution Declaration[2] **signed by your institute's administration (HR).**
    - Passport
2. When your pre-registration is accepted by the CERN users office you will receive an email telling you how to activate your CERN computer account. However, you cannot activate your CERN EDH account until you arrive at CERN and complete the registration process; this means you should register for hands on safety courses via email, see Item 7.
3. Follow the online mandatory CERN safety courses: Safety at CERN, Radioprotection Awareness, Emergency evacuation, Computer Security, Security - Awareness and Data Privacy Basics - elearning.
    - If you have activated your CERN account, you can access the mandatory on-line courses at the web page lms.cern.ch, from your computer, inside or outside CERN.
    - If you have not activated your CERN account, there are some computers available for use, without the need to log in, in the reception building 33 (Your CERN badge will be needed in order to prove your identity).
4. Complete the following online courses available at https://lms.cern.ch:
    - Electrical Safety - Awareness Course - Fundamentals
    - Electrical Safety - Awareness Course - Facilities

    If you have not activated your CERN account see the second part of Item 3.
5. When you arrive at CERN go to the Users Office to complete your registration (Opening hours: 08:30 - 12:30 and 14:00 —- 16:00 but closed Wednesday mornings).
6. Get your CERN access card in Building 33
7. Follow the in-person ISOLDE RP safety course and the "Electrical Safety-Working in EP experiments" course for which you will have to register well in advance[3]. These take place on Tuesdays at the training centre (Building 6959) in Prevessin; the Electrical course takes place on Tuesday morning and the RP course on Tuesday afternoon; see the article "News for Users 2026" for information on the availability of these courses during LS3. If you do not have your own transport, you can take CERN Shuttle 2 from building 500. The timetable for this is here.

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[1] For information see the CERN users' office

[2] The Home Institute Declaration should not be signed by the person nominated as your team leader.

[3] For information about how to register see http://isolde.cern/get-access-isolde-facility

[4] http://cern.ch/service-rp-dosimetry (open only in the mornings 08:30 - 12:00).

8. Obtain a permanent radiation dosimeter at the Dosimetry service, located in Building 33[4] (Opening hours: Mon. to Fri. 08:30 —- 12:00). The "certificate attesting the suitability to work in CERN's radiation areas" [5] signed by your institute will be required. *If you do not need the dosimeter in the following month, it should be returned to the Dosimetry service at the end of your visit.*

9. Apply for access to "ISOHALL" using ADAMS: https://www.cern.ch/adams. (This can be done by any member of your collaboration, typically the contact person, having an EDH account[6]). Access to the hall is via your dosimeter.

   Find more details about CERN User registration see the Users Office website. For the latest updates on how to access the ISOLDE Hall see the ISOLDE website.

   New users are also requested to visit the ISOLDE User Support Office while at CERN. Opening hours: Monday to Friday 08:30 - 12:30

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More contact information at ISOLDE contacts and at ISOLDE people.

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[5] The certificate can be found via http://isolde.cern/get-access-isolde-facility

[6] Eventually you can contact Jenny or the Physics coordinator.